Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities Excepted from Take Prohibitions

U.S. Fish and Wildlife Service
Regions 2, 3, 4, 5, and 6

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EXECUTIVE SUMMARY

This Endangered Species Act (Act) Biological Opinion (BO) addresses the effects to the northern long-eared bat (NLEB) resulting from the Service's finalization of a special rule under the authority of section 4(d) of the Act. It also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis conducted under the umbrella of the final 4(d) rule. The Service has not designated or proposed critical habitat for the NLEB; therefore, this BO does not address effects to critical habitat. Because we anticipate continued NLEB declines as white-nose syndrome (WNS) spreads, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the standard reinitiation criteria are triggered.

The final rule addresses both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS as follows:

- The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when (1) necessary to protect human health; (2) in instances of removal of NLEBs from human structures; or (3) the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.
- The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).
- Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula, which may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present.
- Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula.
- Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31).
- Removal of hazardous trees for the protection of human life and property is not prohibited.

Federal agencies can rely upon the finding of this BO to fulfill their project-specific section 7(a)(2) responsibilities if they utilize the optional framework as described. The framework requires prior notification of activities that may affect the NLEB, along with a determination that the action would not cause prohibited incidental take. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates project-level consultation for the NLEB is required. If the Service does not respond within 30 days, the action agency may consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic BO. Action agencies must also report if actions deviate from the determination, along with the surveys of any surveys.

The Action Area addressed in this BO includes the entire range of the NLEB within the United States, which includes all or portions of 37 States and the District of Columbia from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina. Within the Action Area, the WNS zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming.

Status of the NLEB

The disease WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance. Data support substantial declines in the Eastern range and portions of the Midwest range. We expect further declines as the disease continues to spread across the species' range. NLEBs continue to be distributed across much of the historical range, but there are many gaps where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations. Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines.

We estimate that the range-wide population of NLEBs is comprised of about 6.5 million adults. This population estimate was calculated for the purposes of assessing the potential relative impact of activities contemplated in this BO, and it has limitations and a substantial amount of uncertainty.

Effects of the Action

The NLEB is likely to be affected by many activities which are not prohibited in the final 4(d) rule. We address the general effects of different activities, which we categorized into 7 general groups: (1) capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016; (2) removal from human structures; (3)

timber harvest; (4) prescribed fire; (5) forest conversion; (6) wind turbine operation; and (7) other activities that may affect the NLEB. The effects of category #1 are not addressed in this consultation.

Based on the available scientific literature, we identified various pathways by which environmental changes (stressors) caused by the Action may affect individual NLEB and the expected responses of individuals exposed to the stressors. General response categories include potentially increased fitness, reduced fitness, disturbance, and harm. We do not have enough information to quantify the effects of removal from human structures and the "other" category of activities that may affect the NLEB. For pathways associated with timber harvest, prescribed fire, and forest conversion, we estimate the number of NLEB individuals exposed by computing the expected overlap between the activities and NLEB-occupied habitats in each state. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates.

Based on these estimations, we anticipate that up to 117,267 NLEB (1.2% of the total population) will be disturbed and 3,285 pups (0.1% of the total pup population) and 980 adults (less than 0.02% of the total adult population) will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation. We consider these numbers to be overestimates based on our methodology. Additional harm is anticipated for the unquantified effects from removal from human structures and "other" activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers estimated. In addition, we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population.

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states, less than 1% of pups will be harmed in all states, and less than 1% of adults will be harmed in all states. Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species.

Conclusion

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not

exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service's biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB.

This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in this BO. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

BIOLOGICAL OPINION

A Biological Opinion (BO) is the document required under the Endangered Species Act of 1973 (Act), as amended, that states the opinion of the U.S. Fish and Wildlife Service (Service) as to whether a proposed federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

The action evaluated in this BO is the Service's finalization of a special rule under the authority of section 4(d) of the Act for the northern long-eared bat (*Myotis septentrionalis*) (NLEB). Section 9 of the Act generally prohibits the "take" of a species listed as endangered. The Act and its implementing regulations (50 CFR 17) define take as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. The Act does not specify particular prohibitions for threatened species. Instead, under section 4(d), the Secretary of the Interior has the discretion to issue such regulations to provide for the conservation of threatened species, which may include prohibitions under section 9. This BO also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis under the umbrella of activities excepted from take prohibitions in the Service's final 4(d) rule.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species (50 CFR §402.02). This BO examines whether projects and activities implemented that are likely to adversely affect the NLEB, but would not cause take prohibited under the final 4(d) rule , are likely to jeopardize the continued existence of the NLEB.

The Service anticipates that white-nose syndrome (WNS), the disease causing the decline of the species, will spread throughout the range of the NLEB by 2023-2028 (Federal Register [FR]80[63]:17974). In listing rule, we determined that the NLEB is not currently in danger of extinction throughout all of its range, but if similar declines occur after WNS spreads throughout its entire range, the NLEB may be in danger of extinction. We expect that the status of the species will continue to decline as WNS reaches new areas; therefore, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the reinitiation criteria described in Section 7 (Reinitiation Notice) of this BO are triggered. We believe this is a reasonable approach given that the range-wide decline of the NLEB due to WNS

may reveal that the action may affect the NLEB in a manner or to an extent not previously considered.

1 DESCRIPTION OF THE PROPOSED ACTION

1.1 BACKGROUND

The proposed action is the finalization of the interim 4(d) rule for the NLEB and evaluation of activities excepted from take prohibitions. This rule replaces an interim 4(d) rule established concurrently with the listing of the NLEB as a threatened species on April 2, 2015 (FR 80[63]:17974), under the Act. The interim 4(d) rule:

(1) prohibits purposeful take of NLEBs throughout the species' range, except in instances of removal of NLEBs from human structures;
(2) authorized capture and handling of NLEB by individuals permitted to conduct these same activities for other bats (for a period of 1 year after the effective date of the interim 4(d) rule);
(3) in areas not yet affected by white-nose syndrome (WNS), all incidental take resulting from any otherwise lawful activity is excepted from prohibition;
(4) in areas currently known to be affected by WNS, all incidental take prohibitions apply, except take attributable to forest management practices, maintenance and limited expansion of transportation and utility rights-of-way, prairie habitat management, and limited tree removal projects, provided these activities protect known maternity roosts and hibernacula; and
(5) removal of hazardous trees for the protection of human life or property is excepted from the take prohibition.

The listing and interim 4(d) rule went into effect on May 4, 2015, and the interim 4(d) rule remains in effect until a final 4(d) rule is published in the Federal Register.

1.2 U.S. FISH AND WILDLIFE SERVICE ACTION

The Service is finalizing the interim 4(d) rule for the NLEB. The final rule will address both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS. The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when:

- necessary to protect human health;
- in instances of removal of NLEBs from human structures; or

- the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.

After May 3, 2016, a permit pursuant to Section 10(a)(1)(A)[1] of the Act is required for the capture and handling of NLEBs outside of human structures. We define human structures as houses, garages, barns, sheds, and other buildings designed for human entry.

"Incidental taking" is defined at 50 CFR 17.3 as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, an otherwise lawful activity." Incidental take within the context of the final 4(d) rule is regulated in distinct and separate manners relative to the geographic location of the proposed activity and the occurrence of WNS. The WNS zone provides the boundary for implementation of the final rule. It is defined as the set of counties with confirmed evidence of the fungus causing the disease (*Pseudogymnoascus destructans*, or Pd) or WNS, plus a 150-mile (241 km) buffer from the Pd-positive county line to account for the spread of the fungus from one year to the next. In instances where the 150-mile (241 km) buffer line bisects a county, the entire county is included in the WNS zone. The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).

Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula (which includes caves, mines, and other locations where bats hibernate in winter). Take of NLEBs inside of hibernacula may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present, if the activity will impair essential behavioral patterns (e.g., sheltering) and cause harm. Known hibernacula are defined as locations where one or more NLEBs have been detected during hibernation or detected at the entrance during fall swarming or spring emergence. Any hibernaculum with NLEBs observed at least once is considered a known hibernaculum as long as it remains suitable for NLEB use. A hibernaculum remains suitable for NLEBs even when Pd or WNS has been detected.

For NLEBs outside of hibernacula within the WNS zone, the final 4(d) rule establishes separate incidental take prohibitions for activities involving tree removal and those that do not involve tree removal. Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula or otherwise impair essential behavioral patterns at known hibernacula. Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31). Removal of hazardous trees for the protection of human life

[1] Section 10(a)(1)(A) describes recovery/scientific permits issued for the enhancement of the survival of the species.

and property is not prohibited. Known, occupied maternity roost trees are defined as trees that have had female NLEBs or juvenile bats tracked to them or the presence of female or juvenile bats is known as a result of other methods. Known, occupied maternity roost trees are considered known roosts as long as the tree and surrounding habitat remain suitable for the NLEB.

The final 4(d) rule individually sets forth prohibitions on possession and other acts with unlawfully taken NLEBs, and on import and export of NLEBs. Under this rule, take of the NLEB is also not prohibited for the following: removal of hazardous trees for protection of human life and property; take in defense of life; and take by an employee or agent of the Service, of the National Marine Fisheries Service, or of a State conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with the Service.

Section 4(d) of the Act states that the Secretary shall issue such regulations as she deems "necessary and advisable to provide for the conservation" of species listed as threatened species. The Service determined that the final 4(d) rule is necessary and advisable to provide for the conservation of the NLEB, because it provides for temporary protection of known maternity roost trees during the pup season and to known hibernacula within the WNS zone, and it prohibits most forms of purposeful take throughout the species range. The final rule describes how prohibiting certain types of take is not necessary for the long-term survival of the species, and it acknowledges the importance of addressing the threat of WNS as the primary measure to arrest and reverse the decline of the species.

1.3 OTHER FEDERAL AGENCY ACTIONS

Federal agency actions that involve activities that involve activities not prohibited under the final 4(d) rule may result in effects to the NLEB if the species is exposed to action-caused stressors. Incidental take resulting from these activities is not prohibited; however, the final 4(d) rule does not alter the requirements for consultation under section 7 of the Act, which apply to all federal actions that may affect listed species and designated critical habitat. Section 7(a)(2) of the Act, directs federal agencies, in consultation with the Secretary, to insure that their actions are not likely to jeopardize the continued existence of any listed species, or result in the destruction or adverse modification of designated critical habitat. Therefore, the purpose of section 7(a)(2) is broader than an evaluation of anticipated take and issuance of an Incidental Take Statement.

To address the broader purpose of 7(a)(2) for federal actions that may affect the NLEB but would not cause take prohibited under the final 4(d) rule, the Service's Headquarters Office has requested intra-agency formal consultation with the Service's Midwest Regional Office on the effects of all such federal actions. Because the Service has determined with the final 4(d) rule that regulating incidental take associated with the excepted activities is not necessary or advisable for the conservation of the NLEB, Service Headquarters proposes an optional

framework for subsequent federal agency reliance on the findings of an intra-Service consultation that would streamline section 7(a)(2) compliance for such activities. The primary objective of the framework is to provide an efficient means for Service verification of federal agency determinations that their proposed actions are consistent with those evaluated in the intra-Service consultation and do not require an incidental take statement for the NLEB. Such verification is necessary because incidental take is prohibited in the vicinity of known hibernacula and known roosts, and these locations are continuously updated. We do not include specific action agencies or their specific actions in this BO; rather, we focus on the types of activities that may affect the NLEB and conduct our jeopardy analysis on these activities. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the following framework:

1. For all federal activities that may affect the NLEB, the action agency will provide project-level documentation describing the activities that are excepted from incidental take prohibitions and addressed in this consultation. The federal agency must provide written documentation to the appropriate Service Field Office when it is determined their action may affect (i.e., not likely to adversely affect or likely to adversely affect) the NLEB, but would not cause prohibited incidental take. This documentation must follow these procedures:

    a. In coordination with the appropriate Service Field Office, each action agency must make a determination as to whether their activity is excepted from incidental taking prohibitions in the final 4(d) rule. Activities that will occur within 0.25 mile of a known hibernacula or within 150 feet of known, occupied maternity roost trees during the pup season (June 1 to July 31) are not excepted pursuant to the final 4(d) rule. This determination must be updated annually for multi-year activities.
    b. At least 30 days in advance of funding, authorizing, or carrying out an action, the federal agency must provide written notification of their determination to the appropriate Service Field Office.
    c. For this determination, the action agency will rely on the definitions of prohibited activities provided in the final 4(d) rule and the activities considered in this consultation.
    d. The determination must include a description of the proposed project and the action area (the area affected by all direct and indirect project effects) with sufficient detail to support the determination.
    e. The action agency must provide its determination as part of a request for coordination or consultation for other listed species or separately if no other species may be affected.
    f. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates consultation for the NLEB is required; i.e., where the proposed project includes an activity not covered by the 4(d) rule and thus not addressed in the Biological Opinion and is subject to additional consultation.
    g. If the Service does not respond within 30 days under (f) above, the action agency

may presume its determination is informed by best available information and consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic Biological Opinion.

2. Reporting
    a. For monitoring purposes, the Service will assume all activities are conducted as described. If an agency does not conduct an activity as described, it must promptly report and describe such departures to the appropriate Service Field Office.
    b. The action agency must provide the results of any surveys for the NLEB to the appropriate Service Field Office within their jurisdiction.
    c. Parties finding a dead, injured, or sick NLEB must promptly notify the appropriate Service Field Office.

If a Federal action agency chooses not to follow this framework, standard section 7 consultation procedures will apply.

Section 7(a)(1) of the Act directs Federal agencies, in consultation with and with the assistance of the Secretary (a function delegated to the Service), to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Service Headquarters provides to federal action agencies who choose to implement the framework described above several conservation recommendations for exercising their 7(a)(1) responsibility in this context. Conservation recommendations are discretionary federal agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Service Headquarters recommends that the following conservation measures to all Federal agencies whose actions may affect the NLEB:

1. Perform NLEB surveys according to the most recent Range-wide Indiana Bat/NLEB Summer Survey Guidelines. Benefits from agencies voluntarily performing NLEB surveys include:
    a. Surveys will help federal agencies meet their responsibilities under section 7(a)(1) of the Act. The Service and partners will use the survey data to better understand habitat use and distribution of NLEB, track the status of the species, evaluate threats and impacts, and develop effective conservation and recovery actions. Active participation of federal agencies in survey efforts will lead to a more effective conservation strategy for the NLEB.
    b. Should the Service reclassify the species as endangered in the future, an agency with a good understanding of how the species uses habitat based on surveys within its action areas could inform greater flexibility under section 7(a)(2) of the Act. Such information could facilitate an expedited consultation and incidental take statement that may, for example, exempt taking associated with tree removal during the active season, but outside of the pup season, in known occupied habitat.
2. Apply additional voluntary conservation measures, where appropriate, to reduce the

impacts of activities on NLEBs. Conservation measures include:

a. Conduct tree removal activities outside of the NLEB pup season (June 1 to July 31) and/or the active season (April 1 to October 31). This will minimize impacts to pups at roosts not yet identified.
b. Avoid clearing suitable spring staging and fall swarming habitat within a 5-mile radius of known or assumed NLEB hibernacula during the staging and swarming seasons (April 1 to May 15 and August 15 to November 14, respectively).
c. Manage forests to ensure a continual supply of snags and other suitable maternity roost trees.
d. Conduct prescribed burns outside of the pup season (June 1 to July 31) and/or the active season (April 1 to October 31). Avoid high-intensity burns (causing tree scorch higher than NLEB roosting heights) during the summer maternity season to minimize direct impacts to NLEB.
e. Perform any bridge repair, retrofit, maintenance, and/or rehabilitation work outside of the NLEB active season (April 1 to October 31) in areas where NLEB are known to roost on bridges or where such use is likely.
f. Do not use military smoke and obscurants within forested suitable NLEB habitat during the pup season (June 1 to July 31) and/or the active season (April 1 to October 31).
g. Minimize use of herbicides and pesticides. If necessary, spot treatment is preferred over aerial application.
h. Evaluate the use of outdoor lighting during the active season and seek to minimize light pollution by angling lights downward or via other light minimization measures.
i. Participate in actions to manage and reduce the impacts of white-nose syndrome on NLEB. Actions needed to investigate and manage white-nose syndrome are described in a national plan the Service developed in coordination with other state and federal agencies (Service 2011).

1.4 ACTION AREA

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The “Action Area” for this consultation includes the entire range of the NLEB within the United States, which includes all or portions of the following 37 States and the District of Columbia: Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Within the Action Area, the WNS

zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming (Figure 1.1) (note: tables and figures for each major section of this BO appear at the end of the section). The WNS zone map is updated on the first of every month (http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf).

1.5 ACTIVITIES NOT EVALUATED IN THIS BIOLOGICAL OPINION

The following general categories of activities are prohibited under the final 4(d) rule within the WNS zone:

1. Activities resulting in the disruption or disturbance of NLEBs in their hibernacula.
2. Activities resulting in the physical or other alteration of a hibernaculum's entrance or its environment at any time of year.
3. Tree clearing activities within 0.25 miles of a known NLEB hibernaculum.
4. Tree clearing activities that result in cutting or destroying known, occupied maternity roost trees or any other trees within a 150 ft radius around the roost tree during the pup season (June 1 – July 31).

Separate project-specific section 7 consultation is required for these activities; therefore, they are not addressed further in this consultation.

1.6 TABLES AND FIGURES FOR DESCRIPTION OF THE ACTION

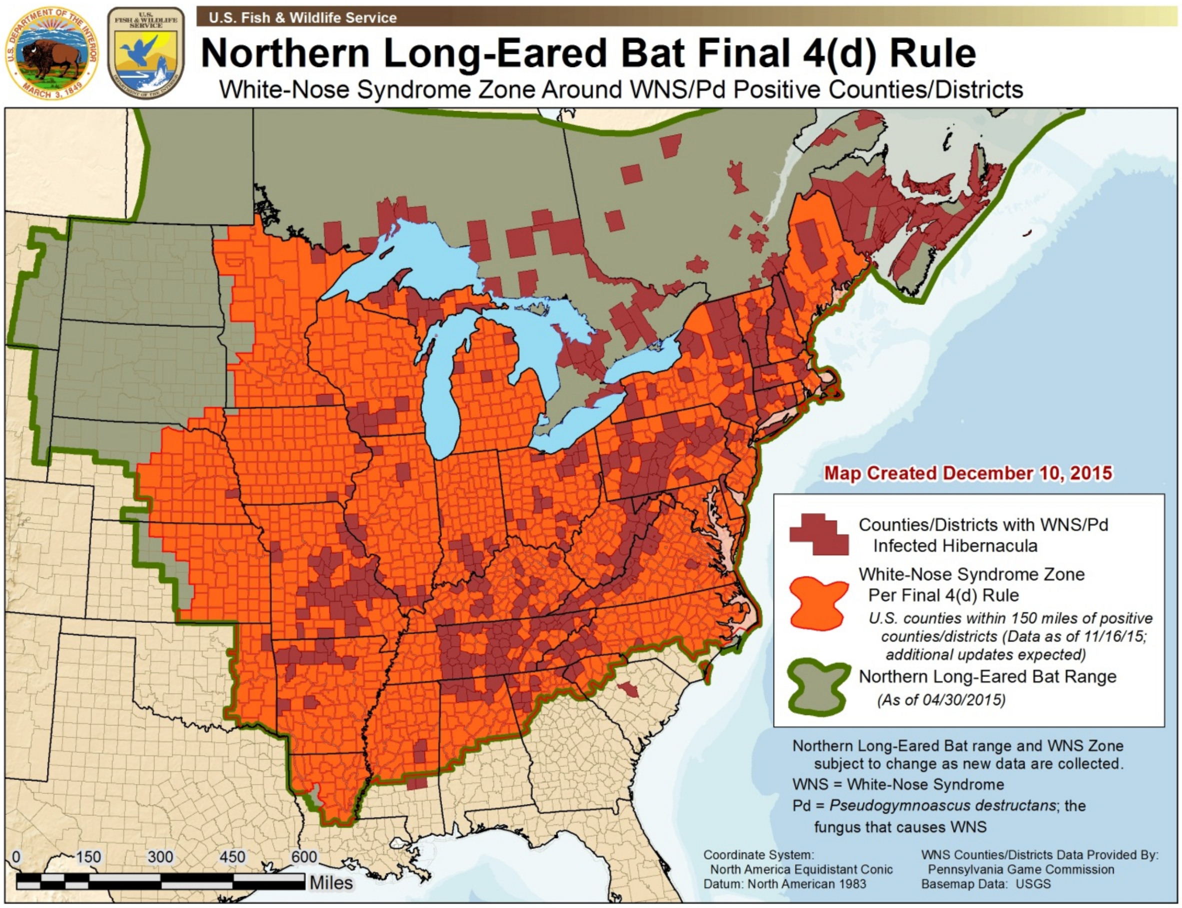

Figure 1.1. The NLEB WNS Zone around WNS/Pd positive counties or districts.

2 STATUS OF THE SPECIES/CRITICAL HABITAT

As described in Section 1, the Service listed the NLEB as a threatened species on April 2, 2015. The final rule determined that critical habitat designation for the NLEB was prudent, but not determinable at the time. The final listing rule describes the status of the species in detail and is hereby incorporated by reference. We summarize and paraphrase portions of the final rule in this section that are most relevant to an evaluation of the proposed Action. Additional information and citations can be found in the final listing rule.

2.1 SPECIES BACKGROUND & HABITAT

The NLEB is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. NLEB generally hibernate between mid-fall through mid-spring each year. The spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between June and early July, with nursing continuing until weaning, which is shortly after young become volant (able to fly) in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

2.1.1 SUMMER HABITAT AND ECOLOGY

Suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

After hibernation ends in late March or early April (as late as May in some northern areas), most NLEB migrate to summer roosts. For purposes of this BO, we define the NLEB active season as the period between emergence and hibernation from April 1 – October 31. We recognize that the active season is variable across the action area depending on latitude, elevation, and weather conditions; however, we believe this range captures most of the period throughout the range in most years. The spring migration period typically runs from mid-March to mid-May (Caire et al. 1979; Easterla 1968; Whitaker and Mumford 2009). The NLEB is not considered to be a long distance migrant (typically 40-50 miles). Males and non-reproductive females may summer near hibernacula, or migrate to summer habitat some distance from their hibernaculum.

After emergence, female NLEBs actively form colonies in the summer (Foster and Kurta 1999) and exhibit fission-fusion behavior (Garroway and Broders 2007), where members frequently coalesce to form a group, but composition of the group is in flux (Barclay and Kurta 2007). As part of this behavior, NLEBs switch tree roosts often (Sasse and Pekins 1996), typically every 2 to 3 days (Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). NLEB maternity colonies range widely in size (reported range of 7 to 100; Owen et al. 2002; Whitaker and Mumford 2009), although about 30-60 may be most common (Whitaker and Mumford 2009; Caceres and Barclay 2000; Service 2014).

NLEBs show interannual fidelity to roost trees and/or maternity areas. They use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012) with multiple alternate roost trees. NLEB roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). NLEB are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. NLEBs have also been occasionally found roosting in structures like buildings, barns, sheds, houses, and bridges (Benedict and Howell 2008; Krochmal and Sparks 2007; Timpone et al. 2010; Service 2014).

Summer home range includes both roosting and foraging areas, and range size may vary by sex. Maternity roosting areas have been reported to vary from mean of 21 to 179 acres (Owen et al. 2003; Broders et al. 2006; Lacki et al. 2009) to a high of 425 acres (Lacki et al. 2009). Foraging areas are six or more times larger (Broders et al. 2006; Henderson and Broders 2008). The distance traveled between consecutive roosts varies widely from 20 ft (Foster and Kurta 1999) to 2.4 miles (Timpone et al. 2010). Likewise, the distance traveled between roost trees and foraging areas in telemetry studies varies widely, e.g., a mean of 1,975 ft (Sasse and Perkins 1996) and a mean of 3,609 ft (Henderson and Broders 2008). Circles with a radius of these distances have an area of 281 and 939 acres. Based on reported maximum individual home range (425 acres) and travel distances between roosts and foraging areas described above (939 acres), we use 1,000 acres for purposes of this BO as the area a colony uses. An analysis of mist net survey data in Kentucky (Service 2014, unpublished data cited in the final listing rule) shows that most males and non-reproductive females are captured in the same locations as reproductively active females, suggesting substantial overlap in the summer home range of reproductive females and other individuals (94%).

NLEBs are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant between early July and early August. For purposes of this BO and the final 4(d) rule, we define the pup season (i.e., the period of non-volancy) as June 1 – July 31.

2.1.2 WINTER HABITAT AND ECOLOGY

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEB during the winter that have yet to be documented. Generally, NLEB hibernate from October to April depending on local climate (November-December through March in southern areas with emergence as late as mid-May in some northern areas).

Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

NLEB tend to roost singly or in small groups (Service 2014), with hibernating population sizes ranging from just a few individuals to around 1,000 (Service unpublished data). NLEB display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940; Whitaker and Rissler 1992; Caceres and Barclay 2000). NLEB have shown a high degree of philopatry (i.e., using the same site multiple years) to the hibernacula used, returning to the same hibernacula annually.

2.1.3 SPRING STAGING AND FALL SWARMING HABITAT AND ECOLOGY

Upon arrival at hibernacula in mid-August to mid-November, NLEB “swarm,” a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum at which they had been mating. A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas).

Reproductively active females store sperm through the winter from autumn copulations. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as “staging,” a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

In general, NLEB use roosts in the spring and fall similar to those selected during the summer. Suitable spring staging/fall swarming habitat consists of the variety of forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 miles of a hibernaculum.

2.2 DISTRIBUTION AND RANGE

The NLEB ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Figure 2.1) (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011). In the United States, the species' range reaches 37 states from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario. However, throughout the majority of the species' range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).

The U.S. portion of the NLEB's range is discussed in this BO in four parts: Eastern, Midwest, Southern, and Western. This is done solely for purposes of analysis and discussion; there is currently no indication that these are distinct populations. The Eastern range comprises Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia. The Midwest range includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The Southern range comprises Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, and Tennessee, and the Western range includes Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Although NLEBs are typically found in low numbers in inconspicuous roosts, most records of NLEB are from winter hibernacula surveys (Caceres and Pybus 1997). There are currently 1,508 hibernacula known throughout the species' range in the United States (Table 2.1). The majority of the known hibernacula occur within the Eastern (39%) and the Midwest range (38), followed by 21 percent in the Southern range, and 2 percent in the Western range. Even prior to WNS, many hibernacula contained only a few (1 to 3) individuals (Whitaker and Hamilton 1998). There are likely many more unknown hibernacula.

There have also been many summer mist-net and acoustic surveys conducted within the range of the NLEB, but the surveys have not been complied into a central database across the species' range. The data is housed with the state natural resources programs, state natural heritage programs, or the local Service field offices. We are unable to report the total number of locations with NLEBs; however, we have compiled the total number of known maternity roost trees in each state (Table 2.1). There are 1,744 known maternity roost trees in 19 of 37 states, with 42% occurring in the Southern range, 30% in the Midwest, and 28% in the Eastern range. There are no known maternity roost trees in the Western range. There are limitations to these data because

most states and natural heritage programs have not been tracking NLEB occurrences or individual roosts.

The current range and distribution of NLEB must be described and understood within the context of the impacts of WNS. Prior to the onset of WNS, the best available information on NLEB came primarily from surveys (primarily focused on Indiana bat or other bat species) and some targeted research projects. In these efforts, NLEB was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and abundant throughout its historic range (Caceres and Barclay 2000). NLEBs continue to be distributed across much of the historical range, but there are many gaps within the range where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations.

2.3 STATUS AND THREATS

2.3.1 WHITE-NOSE SYNDROME

WNS is an emerging infectious wildlife disease caused by a fungus of European origin, Pd, which poses a considerable threat to hibernating bat species throughout North America, including the NLEB (Service 2011). WNS is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). No other threat is as severe and immediate for the NLEB as the disease WNS. There is no doubt that NLEB populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the East to the Midwest and the South. As of November 2015, WNS or Pd was confirmed in 30 of the 37 states within the species' range (Figure 1.1; Table 2.2). Data support substantial declines in the Eastern range and portions of the Midwest range. In addition, there are apparent population declines at most hibernacula with WNS in the Southern range. We expect further declines as the disease continues to spread across the species' range.

Post-WNS hibernacula counts available from the northeast U.S. show the most substantial population declines for the NLEB. Turner et al. (2011) compared the most recent pre-WNS count to the most recent post-WNS count for six cave bat species and reported a 98 percent total decline in the number of hibernating NLEB at 30 hibernacula in New York, Pennsylvania, Vermont, Virginia, and West Virginia through 2011. For the final listing rule, the Service conducted an analysis of additional survey information at 103 sites across 12 U.S. States and Canadian provinces (New York, Pennsylvania, Vermont, West Virginia, Virginia, New Hampshire, Maryland, Connecticut, Massachusetts, North Carolina, New Jersey, and Quebec)

and found comparable declines in winter colony size. At these sites, total NLEB counts declined by an average of 96 percent after the arrival of WNS; 68 percent of the sites declined to zero NLEB, and 92 percent of sites declined by more than 50 percent. Frick et al. (2015) consider the NLEB now extirpated from 69 percent of the hibernacula in Vermont, New York, Pennsylvania, Maryland, Virginia, and West Virginia that had colonies of NLEB prior to WNS. Langwig et al. (2012) reported that 14 populations of NLEB in New York, Vermont, and Connecticut became locally extinct within 2 years due to disease.

Long-term summer survey data (including pre- and post-WNS) for the NLEB, where available, corroborate the population decline evident in hibernacula survey data. For example, summer surveys from 2005 – 2011 near Surry Mountain Lake in New Hampshire showed a 98 percent decline in capture success of NLEB post-WNS, which is similar to the hibernacula data for the State (a 95 percent decline) (Moosman et al. 2013). Mist-netting data from Pennsylvania indicate that NLEB captures declined by 46 percent in 2011, 63 percent in 2012, 76 percent in 2013, and 94 percent in 2014, compared to the average pre-WNS capture rate between 2001 to 2007 (Butchkoski 2014; Pennsylvania Game Commission, unpublished data). The NLEB is more commonly encountered in summer mist-net surveys in the Midwest; however, similar rates of population decline are already occurring in Ohio and Illinois. Early reports also indicate declines in Missouri and Indiana (80 FR 17979-17980). Other data, much of it received as comments on the proposed listing rule from State wildlife agencies, demonstrate that various measures of summer NLEB abundance and relative abundance (mist net surveys, acoustic surveys) have declined following detection of WNS in the state.

Although the dispersal rate of Pd across the landscape and the onset of WNS after the fungus arrives at a new site are variable, it appears unlikely that any site within the range of the NLEB is not susceptible to WNS. Some evidence suggests that certain microclimatic conditions may hinder disease progression at some sites, but given sufficient exposure time, WNS has had similar impacts on NLEB everywhere the disease is documented. Absent direct evidence that some NLEB exposed to the fungus do not contract WNS, available information suggests that the disease will eventually spread throughout the species' range. As described in Section 1 of this BO, we anticipate that WNS will spread throughout the range of the NLEB by 2023-2028.

2.3.2 OTHER THREATS

Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. The final listing rule for the NLEB describes known threats to the species under each of the five statutory factors for listing decisions, of which disease/predation, discussed above, is the dominant factor. We summarize here the findings of the final listing rule regarding the other four factors that are relevant to this consultation.

Human and non-human modification of hibernacula, particularly altering or closing hibernacula entrances, is considered the next greatest threat after WNS to the NLEB. Some modifications, e.g., closure of a cave entrance with structures/materials besides a bat-friendly gate, can cause a partial or complete loss of the utility of a site to serve as hibernaculum. Humans can also disturb hibernating bats, either directly or indirectly, resulting in an increase in energy-consuming arousal bouts during hibernation (Thomas 1995; Johnson et al. 1998).

During the summer, NLEB habitat loss is primarily due to forest conversion and forest management. Throughout the range of NLEB, forest conversion is expected to increase due to commercial and urban development, energy production and transmission, and natural changes. The 2010 Resources Planning Act Assessment projects forest losses of 16–34 million acres (or 4–8 percent of 2007 forest area) across the conterminous United States, and forest loss is expected to be concentrated in the southern United States, with losses of 9–21 million acres (USFS 2012). Forest conversion causes loss of potential habitat, fragmentation of remaining habitat, and if occupied at the time of the conversion, direct injury or mortality to individuals. Forest management activities, unlike forest conversion, typically result in temporary impacts to the habitat of NLEB, but like forest conversion, may also cause direct injury or mortality to individuals. The net effect of forest management may be positive, neutral, or negative, depending on the type, scale, and timing of various practices. The primary potential benefit of forest management to the species is perpetuating forests on the landscape that provide suitable roosting and foraging habitat.

Wind energy facilities are known to cause mortality of NLEB. While mortality estimates vary between sites and years, sustained mortality at particular facilities could cause declines in local populations. Wind energy development within portions of the species' range is projected to continue.

Climate change may also affect this species, as NLEB are particularly sensitive to changes in temperature, humidity, and precipitation. Climate change may indirectly affect the NLEB through changes in food availability and the timing of hibernation and reproductive cycles.

Environmental contaminants, in particular insecticides, other pesticides, and inorganic contaminants, such as mercury and lead, may also have detrimental effects on NLEB. Contaminants may bio-accumulate (become concentrated) in the tissues of bats, potentially leading to a myriad of sub-lethal and lethal effects. NLEBs may also be indirectly affected through a reduction in available insect prey.

Fire is one of the environmental stressors that contribute to the creation of snags and damaged trees on the landscape, which NLEB frequently use as summer roosts. Fire may also kill or injure

bats, especially flightless pups. Prescribed burning is a common tool for forest management in many parts of the species' range.

There is currently no evidence that the natural or manmade factors discussed above (hibernacula modification, forest conversion, forest management, wind energy, climate change, contaminants, fire) have separately or cumulatively contributed to significant range-wide population effects on the NLEB prior to the onset of WNS. However, declines due to WNS have significantly reduced the number and size of NLEB populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual NLEB sickened or struggling with infection by WNS may be less able to survive other stressors. Second, NLEB populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less able to recover making them more prone to extirpation. The status and potential for these impacts will vary across the range of the species.

2.4 POPULATION DYNAMICS

Hibernacula counts are generally the best census method for most bats that hibernate, because individuals are concentrated and relatively stationary. However, because the NLEB is difficult to detect in hibernacula, moves between hibernacula during the winter, and many hibernacula are likely not known, a range-wide population estimate for the species is not available. The NLEB is most widely dispersed on the landscape during the summer where it is most likely exposed, directly or indirectly (i.e., later in time), to the widely dispersed (i.e., not concentrated in a given area) activities that are excepted from take prohibitions under the 4(d) rule.

For purposes of this BO, we estimate NLEB numbers based on total forested acres in each state and assumptions about:

- state-specific occupancy rates;
- forested acres in each state;
- maternity colony home-range size;
- number of adult females per colony;
- overlap between adult male home range and maternity colony home range;
- overlap between maternity colonies; and
- landscape-scale adult sex ratio (we assume 1:1).

We explain these data and assumptions in the following sub-sections.

2.4.1 OCCUPANCY RATES

We requested summer survey results from the three most recent years available from our field offices to provide an estimate of recent occupancy rates. Field offices provided the total number of survey sites (typically mist-net surveys), by state and by year, and the number of sites that captured at least one NLEB. Occupancy rates were calculated using the proportion of sites occupied with NLEB from the total number of sites sampled (Table 2.3). Where no data were available, we used the post-WNS survey data provided by the Forest Service for National Forests within the respective state (Table 2.3). Some states have only 1 or 2 years of data, and others have 8 or more consecutive years of data. In most cases, the numbers and locations of these survey sites do not constitute a representative sample of the available forest habitat in each state. Regardless, the alternative to using these data is to consider the NLEB ubiquitous within forested habitat in each state, which would greatly overestimate occupancy. Instead, we use these data as the best available information from which to make inferences about the extent of NLEB occupancy in each state[2].

Table 2.2 identifies the years in which WNS was detected in the state. We compute pre- and post-WNS occupancy rates as the number of net sites with NLEB divided by the total number of bat capture sites in each state. We applied the occupancy rate listed in Table 2.3 to each state.

2.4.2 TOTAL FORESTED ACRES IN EACH STATE

We compiled the total forested acres for each state from the U.S. Forest Service's 2015 State and Private Forestry Fact sheets (available at http://stateforesters.org/regional-state). We assumed that all forested acres within each state are suitable for the NLEB, which probably overestimates habitat availability but it is not unreasonable given the NLEB's ability to use very small trees (≥ 3 in dbh). We could have estimated the amount of forest in each state in more detail, but our analysis of other factors unrelated to forest cover was limited to statewide data, so we used statewide data throughout the analysis for all factors.

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[2] The occupancy data used in this analysis has many limitations and a substantial amount of uncertainty. Occupancy as used here is the proportion of suitable habitat that is likely to have NLEB present. This is sensitive to the accuracy of the suitable habitat data, the accuracy of the survey data used to estimate the occupancy, and biases in the survey data collection methodology. The definition of suitable habitat used for this analysis is necessarily very general (forested areas) to be applicable across the entire species range. The surveys used to generate the occupancy data were often very sparse and not designed for this purpose. Repurposing of the data may increase the effects of bias in distribution of sample points (in relation to both suitable habitat and bat distributions), sampling methodologies, and sampling timing. We believe that because much of the sampling was not targeted specifically at NLEB and often involves surveys for development or construction projects, survey locations are unlikely to be closely correlated to NLEB distributions, which may minimize the influence of some biases. However, the limitations of the available data and its biases are potentially significant to the occupancy estimates, and this creates uncertainty that we acknowledge. Given these factors, our estimates of population are meant as tool for assessing potential relative impact by providing a scale for comparison, not as a precise estimate of the northern long-eared bat populations.

Not every state is wholly within the range of the NLEB (Figure 2.1), and including the total forested acreage from states not fully within the species' range could greatly overestimate the population size. Therefore, we excluded states with less than 50% of its area within the species range, which eliminated Montana, Wyoming, Oklahoma, Louisiana, Alabama, Georgia, and South Carolina. The inclusion of the full states of Nebraska, Kansas, Mississippi, and North Carolina should compensate for any individuals not included in the excluded states. The list of states included, along with the total forested acres are reported in Table 2.4.

2.4.3 COLONY SIZE (NUMBERS OF BATS AND OCCUPIED AREA)

In addition to the occupancy rates described above, we rely in this BO primarily on colony characteristics reported in the literature to estimate state-wide bat numbers. NLEB colonies are comprised of variable numbers of adult females. Two important studies give a range of 30–60 adult females per colony (see Section 2.1.1). Given the number of colonies that a state likely supports (see Section 2.4.4) (see Section 2.4.4), we then estimate total NLEB numbers in the occupied available habitat using the number of females per colony and assuming a 1:1 adult female/adult male ratio and a maximum of 1 pup per female.

While colony sizes of 30-60 bats may be typical in areas unaffected by WNS, in areas with clear declines in bat populations, these estimates may no longer be appropriate. Declines in total population appear to exceed what could be explained by declines in occupancy rates alone. The total reproductive female population can be described as the product of the average colony size in females and the number of colonies:

[Total female reproductive population = Number of colonies * Mean females per colony] OR N=C*F

If the rate of total population decline exceeds the rate of decline in number of colonies (as described by declines in occupancy) there must also be an additional reduction in the average colony size as well.

Information about total population sizes or average colony sizes is not available on a wide scale. However, there are a few instances where we have obtained data that could be used to approximate rates of population decline without knowing the actual sizes of populations. In Pennsylvania, captures of bats per unit effort have been tracked for several years. Changes in this number of bats per unit effort captured across a wide area could be assumed to mirror changes in the total population for that area. So if the total population declined by 50%, we would expect to see a 50% decline in captures of bats per unit effort as well. The number of bats per unit effort in Pennsylvania declined to 22.3% of pre-WNS levels (averaging capture rates across 2012-2014). Over the same time period, occupancy declined 49.8%. Pre-WNS occupancy was 67.9% of

suitable habitat, while the last three years of data indicate an occupancy rate of 33.8% of suitable habitat (0.338/0.679=0.498).

The change over time of the total female population is going to be a function of the change in the number of colonies and the change in the mean number of females per colony. Or, put another way, the change in females per colony over time can be described by the change in the number of colonies in relation to the change in total female population. So:

$N_t/N_0 = (C_t*F_t)/(C_0*F_0)$ OR $C_t = (N_t/N_0)*(C_0*F_0)/ F_t$ OR $C_t = (N_t/N_0)*C_0/(F_t/ F_0)$

Assuming changes in captures per unit effort is a good approximation for changes in the proportion of remaining bats, and using the decline in occupancy to represent the decline in the number of colonies, with a decline in occupancy of 49.8%, the average colony size is likely to have declined by 55% to approximately 20 bats per colony. (((0.223/1)*45)/(0.498)=20.2)

Similarly, Ohio has seen declines in captures per mist net site to 91.2% of pre-WNS levels, using the average of 2012-2014 rates. While likely to be less accurate to represent population declines than captures per unit effort, captures per mist net site may be a reasonable approximation for total population changes as well. Occupancy rates have been relatively stable in Ohio, increasing slightly from 39.6% over 2007-2010 to 42.1% over 2012-2014 (although with a large drop in 2014). Assuming the captures per mist net site is also a reasonable estimate of the rate of total population decline, a slightly increasing occupancy indicates that declines must be occurring within colonies. The average colony is likely to have declined 14%, to about 39 bats. (((0.912/1)*45)/(1.06) = 38.7)

WNS was first documented in Pennsylvania in 2008-2009 and in Ohio in 2010-2011 (Table 2.2). For the purposes of this BO, we assume that colonies are comprised of 20 females in all states where WNS was documented prior to the winter of 2010-2011 (Table 2.4). Rhode Island does not have any hibernacula; therefore, WNS has not been confirmed in the state. We assume that bats in summer habitat in Rhode Island have been affected by WNS in the surrounding states, and colonies are comprised of 20 females. For all states with WNS documented during or after the winter of 2010-2011, we assume colonies are comprised of 39 females. For states that do not have WNS (including states that have only documented Pd), we use 45 females per colony (the mid-point of the 30–60 range) as the basis for estimating bat numbers. For each colony present in a state, we assume a NLEB population is comprised of 20, 39, or 45 adult females and the same number of sympatric adult males and juveniles following parturition, depending on the status of WNS (Table 2.4).

As described in Section 2.1.1, we use 1,000 acres for purposes of this BO as the area a colony uses. Within this area, one or more members of a colony and sympatric adult males would likely appear in mist net or acoustic surveys. Such appearance is the basis for the occupancy rates we

use to estimate the acreage of available forested habitat that NLEB may use during the active season in the states, which are given in Table 2.4.

Maternity roosting areas are a subset of the 1,000-acre colony size we use in this BO. As described above, Broders et al. (2006) and Henderson and Broders (2008) found that foraging areas were six or more times larger than maternity roosting areas. One sixth of our 1,000-acre colony size is 167 acres, which is within the range of other maternity roosting areas reported (Carter and Feldhamer 2005; Silvis et al. 2015). For purposes of this BO, we use a maternity roosting area of 167 acres. Table 2.5 shows our estimates of the percentage of each state that is used as maternity roost areas based on the number of expected colonies (Table 2.4) and 167 acres per colony.

2.4.4 OVERLAP

Lacking information about the degree of spatial overlap between NLEB maternity colonies, for this BO we assume that colonies do not overlap, e.g., we assume that 1,000 acres of occupied habitat supports one colony. Estimated or assumed occupancy rates in all of the states are all less than 70 percent (Table 2.3); therefore, it is unlikely that limited habitat availability would contribute to substantial colony-range overlap. If incorrect, the possible effect of this assumption is to underestimate the population size in each state (i.e., 1,000 acres supports more than 1 colony).

As described in Section 2.1.1, mist net survey data in Kentucky indicate substantial overlap in the summer home range of reproductive females and males and non-reproductive females (1,712 of 1,825 capture records, or 94 percent). The Service further analyzed this data to determine the percentage of capture locations for males and non-reproductive females that were not capture locations for reproductive female captures or within 3 miles of a reproductive female capture location (Service 2015b). Of 909 capture locations, 87 (9.57 percent) did not have reproductively active females and were more than 3 miles away from captures of reproductive females, suggesting a 100 – 9.57 = 90.43 percent overlap between the home range of individuals belonging to maternity colonies and other individuals. We lack state-specific information about the overlap between reproductively active females and other bats; therefore, for this BO, we assume the 90.43 percent overlap suggested by the Kentucky data. We multiply occupied forest acres by 0.9043 to compute the number of probable maternity colonies; e.g., 100,000 occupied acres × 0.9043 = 90,430 acres supporting 90,430 ÷ 1000 = 91 maternity colonies, rounding up any fractional remainder.

2.4.5 POPULATION ESTIMATES

Table 2.4 provides our estimates of the summer adult population size of NLEB in the 30 states included in the analysis. It relies on the total forested acres and the other assumptions described above; i.e., occupancy rates for each state in Table 2.3, 90.43 percent overlap between the range of males and maternity colonies, 1,000 acres per colony, no overlap between colonies, the number of adult females per colony (20, 39, or 45 depending on WNS), and a 1:1 male/female sex ratio. Here are example calculations for Iowa as reported in Table 2.4:

- 3,013,759 forested acres × 0.417 occupancy rate = 1,256,738 occupied acres;
- 1,256,738 occupied acres × 0.9043 overlap with males = 1,136,467 colony-occupied acres;
- 1,136,467 acres ÷ 1,000 acres per colony = 1,137 colonies;
- 1,137 colonies × 45 adult females per colony = 51,165 adult females; and
- 51,165 adult females + 1 adult male per female (or 51,165 adult males) = 102,330 total adults.

We estimate that the range-wide population of NLEBs is comprised of 6,546,718 adults based on these calculations and the assumption that the 30 states included in the analysis represent the range-wide population. Arkansas supports the largest population (863,850 adults; 13%), followed by Minnesota with 829,890 (13%). Delaware and Rhode Island support the smallest populations with 640 and 1,240 adults, respectively. Based on these estimates, the Midwest supports 43% of the total population followed by the Southern range (38%), the Eastern range (17%), and the Western range (2%).

It is likely that the state populations are overestimates in areas affected by WNS. We used the occupancy data from the last 3 years, but in nearly all WNS areas there is a clear downward trend and most data are at least a year old. Therefore, the occupation rates and resulting population estimates are likely lower in many areas.

2.5 ANALYSIS OF THE SPECIES/CRITICAL HABITAT LIKELY TO BE AFFECTED

As described in Section 1, the NLEB is likely to be adversely affected by the activities which are excepted from incidental take prohibitions in the final 4(d) rule. Many federally listed, proposed, and candidate species, and their designated or proposed critical habitats, occur within the Action Area for this consultation. However, the Service Headquarters has determined that the proposed action will have no effect on any other listed, proposed, or candidate species or designated or proposed critical habitats. The action is the Service's finalization the 4(d) rule for the NLEB. It sets forth the prohibitions for take under section 9(a)(1) of the Act and the exceptions to those

prohibitions. It does not alter in any way the consultation requirements under section 7(a)(2) of the Act. Although this BO provides a framework for streamlined section 7 consultation for federal actions that are consistent with the provisions of the 4(d) rule, the framework only applies to the NLEB. Federal agencies will still be required to consult on activities that may affect other listed species within the Action Area. Therefore, only the NLEB will be considered further in this BO.

2.6 TABLES AND FIGURES FOR STATUS OF THE SPECIES

Table 2.1. Known NLEB hibernacula and known maternity roosts trees by state.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees
Midwest	Iowa	2	14
Midwest	Illinois	44	39
Midwest	Indiana	69	193
Midwest	Michigan	77	25
Midwest	Minnesota	15	102
Midwest	Missouri	269	58
Midwest	Ohio	32	4
Midwest	Wisconsin	67	84
Eastern	Connecticut	8	0
Eastern	Delaware	2	0
Eastern	Maine	3	0
Eastern	Maryland	8	0
Eastern	Massachusetts	7	16
Eastern	New Hampshire	11	0
Eastern	New Jersey	9	47
Eastern	New York	90	27
Eastern	Pennsylvania	322	157
Eastern	Rhode Island	0	0
Eastern	Vermont	16	0
Eastern	Virginia	11	12
Eastern	West Virginia	104	231
Southern	Alabama	11	0
Southern	Arkansas	77	310
Southern	Georgia	6	20
Southern	Kentucky	122	254
Southern	Louisiana	0	0
Southern	Mississippi	0	0
Southern	North Carolina	29	101
Southern	Oklahoma	9	0
Southern	South Carolina	3	0
Southern	Tennessee	61	50
Western	Kansas	1	0
Western	Montana	0	0
Western	Nebraska	2	0
Western	North Dakota	0	0
Western	South Dakota	21	0
Western	Wyoming	0	0
	Total	1,508	1,744

Table 2.2. White-nose syndrome (WNS) and *Pseudogymnoascus destructans* (Pd) occurrence in the 37 States.

REGION	STATE	WNS or Pd Present?	First Winter WNS Confirmed	Documented WNS Mortality in Bats?
Midwest	Iowa	Pd	Pd only (2011-2012)	No
Midwest	Illinois	WNS	2012-2013	Yes
Midwest	Indiana	WNS	2010-2011	Yes
Midwest	Michigan	WNS	2014-2015	Yes
Midwest	Minnesota	Pd	Pd only (2011-2012)	No
Midwest	Missouri	WNS	2011-2012	Yes
Midwest	Ohio	WNS	2010-2011	Yes
Midwest	Wisconsin	WNS	2013-2014	Yes
Eastern	Connecticut	WNS	2008-2009	Yes
Eastern	Delaware	WNS	2009-2010	Yes
Eastern	Maine	WNS	2010-2011	Yes
Eastern	Maryland	WNS	2009-2010	Yes
Eastern	Massachusetts	WNS	2007-2008	Yes
Eastern	New Hampshire	WNS	2008-2009	Yes
Eastern	New Jersey	WNS	2008-2009	Yes
Eastern	New York	WNS	2006-2007	Yes
Eastern	Pennsylvania	WNS	2008-2009	Yes
Eastern	Rhode Island	No	NA	NA
Eastern	Vermont	WNS	2007-2008	Yes
Eastern	Virginia	WNS	2008-2009	Yes
Eastern	West Virginia	WNS	2008-2009	Yes
Southern	Alabama	WNS	2011-2012	Yes
Southern	Arkansas	WNS	2013-2014	Yes
Southern	Georgia	WNS	2012-2013	Yes
Southern	Kentucky	WNS	2010-2011	Yes
Southern	Louisiana	No	NA	NA
Southern	Mississippi	Pd	Pd only (2013-2014)	No
Southern	North Carolina	WNS	2010-2011	Yes
Southern	Oklahoma	Pd	Pd only (2014-2015)	No
Southern	South Carolina	WNS	2012-2013	Yes
Southern	Tennessee	WNS	2009-2010	Yes
Western	Kansas	No	NA	NA
Western	Montana	No	NA	NA
Western	Nebraska	Pd	Pd only (2014-2015)	No
Western	North Dakota	No	NA	NA
Western	South Dakota	No	NA	NA
Western	Wyoming	No	NA	NA

Table 2.3. NLEB summer state-wide occupancy estimates, based on summer survey results.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Midwest	IA	Total Mist Net Sites	2009-2011	24		0		
		Sites with NLEB Captures		10	41.7%	0	N/A	41.7%
	IL	Total Mist Net Sites	2009-2011	40		0		
		Sites with NLEB Captures		25	62.5%	0	N/A	62.5%
	IN	Total Mist Net Sites				283		
		Sites with NLEB Captures			N/A	106	37.5%	37.5%
	MI	Total Mist Net Sites	2004-2014	149		0		
		Sites with NLEB Captures		47	31.5%	0	N/A	31.5%
	MN	Total Mist Net Sites	2013-2014	121		0		
		Sites with NLEB Captures		71	58.7%	0	N/A	58.7%
	MO	Total Mist Net Sites				42		
		Sites with NLEB Captures			N/A	11	26.2%	26.2%
	OH	Total Mist Net Sites	2007-2010	733		2485		
		Sites with NLEB Captures		290	39.6%	1046	42.1%	42.1%
	WI	Total Mist Net Sites				78		
		Sites with NLEB Captures			N/A	35	44.9%	44.9%
Eastern	CT$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	DE^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	ME*	Total Acoustic Sites				180		
		Sites with NLEB Captures			N/A	17	9.4%	9.4%
	MD^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	MA*	Total Acoustic Sites				132		
		Sites with NLEB Captures			N/A	9	6.8%	6.8%
	NH#	Total Mist Net Sites	2002-2004	13		173		
		Sites with NLEB Captures		12	92.3%	17	9.8%	9.8%
	NJ	Total Mist Net Sites	1995-2008	132		25		
		Sites with NLEB Captures		89	67.4%	8	32.0%	32.0%
	NY+#	Total Mist Net Sites	2000-2005	56		45		
		Sites with NLEB Captures		39	69.6%	15	33.3%	33.3%
	PA	Total Mist Net Sites	2001-2007	1069		1469		
		Sites with NLEB Captures		726	67.9%	497	33.8%	33.8%
	RI$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	VT+#	Total Mist Net Sites	2000-2005			12		
		Sites with NLEB Captures			See NY	3	25.0%	9.8%
	VA#	Total Mist Net Sites	2010	27		60		
		Sites with NLEB Captures		27	100.0%	29	48.3%	48.3%
	WV	Total Mist Net Sites	1997-2008	508		97		
		Sites with NLEB Captures		401	78.9%	52	53.6%	53.6%

Table 3.1. Continued.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Southern	AL#	Total Mist Net Sites	2001-2011	179		38		
		Sites with NLEB Captures		48	26.8%	13	34.2%	34.2%
	AR#	Total Mist Net Sites	2009-2013	568		95		
		Sites with NLEB Captures		399	70.2%	62	65.3%	65.3%
	GA#	Total Mist Net Sites	2001-2011	62		18		
		Sites with NLEB Captures		37	59.7%	10	55.6%	55.6%
	KY	Total Mist Net Sites	2005-2010	503		305		
		Sites with NLEB Captures		263	52.3%	124	40.7%	40.7%
	LA$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	MS$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	NC#	Total Mist Net Sites	2000-2012	244		35		
		Sites with NLEB Captures		199	81.6%	14	40.0%	40.0%
	OK	Total Mist Net Sites	2013-2015	28		0		
		Sites with NLEB Captures		13	46.4%	0	N/A	46.4%
	SC$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	TN#	Total Mist Net Sites	2000-2008	221		90		
		Sites with NLEB Captures		153	69.2%	37	41.1%	41.1%
Western	KS+	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	MT+	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	NE+	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	ND+	Total Mist Net Sites	2009-2014	42		0		
		Sites with NLEB Captures		3	7.1%	0	N/A	22.5%
	SD+	Total Mist Net Sites	2003-2006	13		0		
		Sites with NLEB Captures		10	76.9%	0	N/A	22.5%
	WY+	Total Mist Net Sites	2010-2014	56		0		
		Sites with NLEB Captures		12	21.4%	0	N/A	22.5%

* Acoustic data used due to limited amount of mist net data

^ Statewide occupancy estimates from a more in-depth analysis used

Based on data from National Forests in the state

$ Data from nearby states used because statewide data was inadequate or unavailable

+ Data from multiple states were aggregated due to small datasets

Table 2.4. NLEB adult summer population estimates for the 30 states included in analysis.

Region	State	Forested Acres	Percent Occupancy	Occupied Acres	Maternity Colonies	Maternity Colony Size	Adult Females	Total Adults	Total Pups
Midwest	Iowa	3,013,759	41.7%	1,256,738	1,137	45	51,165	102,330	51,165
Midwest	Illinois	4,847,480	62.5%	3,029,675	2,740	39	106,860	213,720	106,860
Midwest	Indiana	4,830,395	37.5%	1,811,398	1,639	39	63,921	127,842	63,921
Midwest	Michigan	20,127,048	31.5%	6,340,020	5,734	39	223,626	447,252	223,626
Midwest	Minnesota	17,370,394	58.7%	10,196,421	9,221	45	414,945	829,890	414,945
Midwest	Missouri	15,471,982	26.2%	4,053,659	3,666	39	142,974	285,948	142,974
Midwest	Ohio	8,088,277	42.1%	3,405,165	3,080	39	120,120	240,240	120,120
Midwest	Wisconsin	16,980,084	44.9%	7,624,058	6,895	39	268,905	537,810	268,905
Eastern	Connecticut	1,711,749	9.4%	160,904	146	20	2,920	5,840	2,920
Eastern	Delaware	339,520	5.0%	16,976	16	20	320	640	320
Eastern	Maine	17,660,246	9.4%	1,660,063	1,502	39	58,578	117,156	58,578
Eastern	Maryland	2,460,652	5.0%	123,033	112	20	2,240	4,480	2,240
Eastern	Massachusetts	3,024,092	6.8%	205,638	186	20	3,720	7,440	3,720
Eastern	New Hampshire	4,832,408	9.8%	473,576	429	20	8,580	17,160	8,580
Eastern	New Jersey	1,963,561	32.0%	628,340	569	20	11,380	22,760	11,380
Eastern	New York	18,966,416	33.3%	6,315,817	5,712	20	114,240	228,480	114,240
Eastern	Pennsylvania	16,781,960	33.8%	5,672,302	5,130	20	102,600	205,200	102,600
Eastern	Rhode Island	359,519	9.4%	33,795	31	20	620	1,240	620
Eastern	Vermont	4,591,280	9.8%	449,945	407	20	8,140	16,280	8,140
Eastern	Virginia	15,907,041	48.3%	7,683,101	6,948	20	138,960	277,920	138,960
Eastern	West Virginia	12,154,471	53.6%	6,514,796	5,892	20	117,840	235,680	117,840
Southern	Arkansas	18,754,916	65.3%	12,246,960	11,075	39	431,925	863,850	431,925
Southern	Kentucky	12,471,762	40.7%	5,076,007	4,591	39	179,049	358,098	179,049
Southern	Mississippi	19,541,284	34.2%	6,683,119	6,044	45	271,980	543,960	271,980
Southern	North Carolina	18,587,540	40.0%	7,435,016	6,724	39	262,236	524,472	262,236
Southern	Tennessee	13,941,333	41.1%	5,729,888	5,182	20	103,640	207,280	103,640
Western	Kansas	2,502,434	22.5%	563,048	510	45	22,950	45,900	22,950
Western	Nebraska	1,576,174	22.5%	354,639	321	45	14,445	28,890	14,445
Western	North Dakota	759,998	22.5%	171,000	155	45	6,975	13,950	6,975
Western	South Dakota	1,910,934	22.5%	429,960	389	45	17,505	35,010	17,505
	Total	281,528,709	37.8%	106,345,057	96,183		3,273,359	6,546,718	3,273,359

Table 2.5. Estimated acreage of NLEB maternity roosting areas for the 30 states included in analysis.

Region	State	Forested Acres	Maternity Colonies[1]	Maternity Roost Area Acres (167 acres per Colony)	Percent of Forest Habitat Used as Maternity Roost Areas
Midwest	Iowa	3,013,759	1,137	189,879	6.30%
Midwest	Illinois	4,847,480	2,740	457,580	9.44%
Midwest	Indiana	4,830,395	1,639	273,713	5.67%
Midwest	Michigan	20,127,048	5,734	957,578	4.76%
Midwest	Minnesota	17,370,394	9,221	1,539,907	8.87%
Midwest	Missouri	15,471,982	3,666	612,222	3.96%
Midwest	Ohio	8,088,277	3,080	514,360	6.36%
Midwest	Wisconsin	16,980,084	6,895	1,151,465	6.78%
Eastern	Connecticut	1,711,749	146	24,382	1.42%
Eastern	Delaware	339,520	16	2,672	0.79%
Eastern	Maine	17,660,246	1,502	250,834	1.42%
Eastern	Maryland	2,460,652	112	18,704	0.76%
Eastern	Massachusetts	3,024,092	186	31,062	1.03%
Eastern	New Hampshire	4,832,408	429	71,643	1.48%
Eastern	New Jersey	1,963,561	569	95,023	4.84%
Eastern	New York	18,966,416	5,712	953,904	5.03%
Eastern	Pennsylvania	16,781,960	5,130	856,710	5.10%
Eastern	Rhode Island	359,519	31	5,177	1.44%
Eastern	Vermont	4,591,280	407	67,969	1.48%
Eastern	Virginia	15,907,041	6,948	1,160,316	7.29%
Eastern	West Virginia	12,154,471	5,892	983,964	8.10%
Southern	Arkansas	18,754,916	11,075	1,849,525	9.86%
Southern	Kentucky	12,471,762	4,591	766,697	6.15%
Southern	Mississippi	19,541,284	6,044	1,009,348	5.17%
Southern	North Carolina	18,587,540	6,724	1,122,908	6.04%
Southern	Tennessee	13,941,333	5,182	865,394	6.21%
Western	Kansas	2,502,434	510	85,170	3.40%
Western	Nebraska	1,576,174	321	53,607	3.40%
Western	North Dakota	759,998	155	25,885	3.41%
Western	South Dakota	1,910,934	389	64,963	3.40%
	Total	281,528,709	96,183	16,062,561	5.71%

[1] From Table 2.4

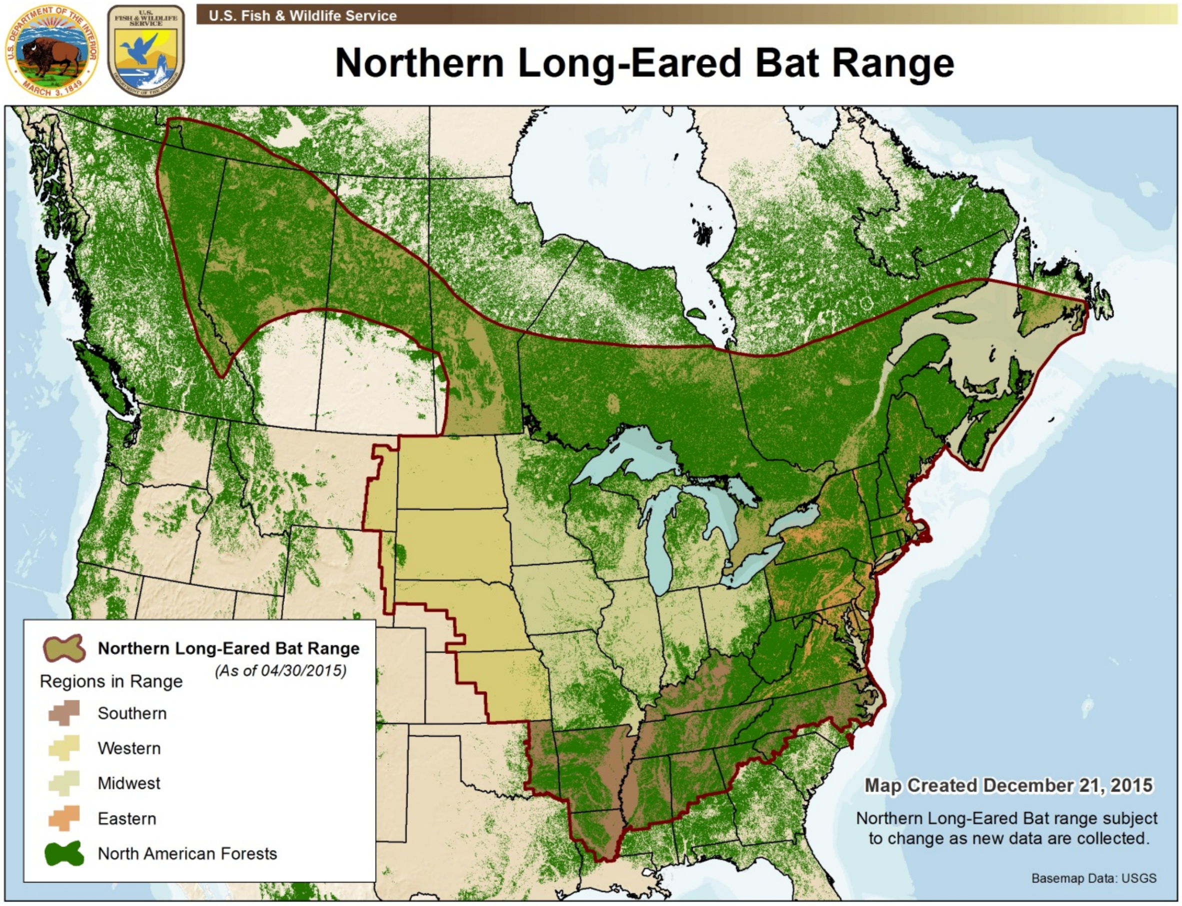

Figure 2.1. Range of the NLEB.

3 ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the action under review.

Because the Action Area covers the entire range of the species within the United States, the environmental baseline is the same as the status of the species discussed in detail in Section 2. No further discussion is needed in this section.

4 EFFECTS OF THE ACTION

This section addresses the direct and indirect effects of the Action on the NLEB, including the effects of interrelated and interdependent activities. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the proposed action and are later in time but still are reasonably certain to occur.

The NLEB is likely to be affected by many activities which are excepted from incidental take prohibitions in the final 4(d) rule. Instead of describing all of the activities, we address the general effects of different activities, which we categorized into 7 general groups:

1. Capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016
2. Removal from human structures
3. Timber harvest
4. Prescribed fire
5. Forest conversion
6. Wind turbine operation
7. Other activities that may affect the NLEB

The effects of category #1 are not addressed in this consultation because a separate section 10(a)(1)(A) permit and section 7 consultation will be required for those activities after May 3, 2016, as required by the final 4(d) rule. Until that time, we expect limited effects because NLEBs are currently hibernating and most surveys are conducted during the summer. Winter hibernacula surveys could affect the NLEB until May 3, 2016; however, researchers conducting winter surveys must have a section 10(a)(1)(A) permit for other listed bat species. The Service

completed three BOs for the effects of existing bat section 10(a)(1)(A) permits on the NLEB in the Midwest, Mountain/Prairie and Southeast Regions. The adverse effects from winter hibernacula surveys are addressed in those BOs, which were non-jeopardy opinions.

The final 4(d) rule does not prohibit incidental take outside of the WNS zone. This effects analysis does not address the differences in prohibitions outside of the WNS zone because current actions that may affect the NLEB have not been shown to have significant impacts on NLEBs before WNS was detected. We expect that the impacts will be further reduced in the areas outside of the WNS zone because less than 2% of the total estimated population of NLEB occurs in the areas outside of the WNS zone (Section 2.4.5), and the habitat is more sparse (Figure 2.1). In addition, we anticipate that the WNS zone will expand further into the western states fairly quickly. Therefore, we did not attempt to analyze the different prohibitions between the zones.

4.1 EFFECTS ANALYSIS METHODOLOGY

For each of the remaining six categories of activities described above, we apply the following steps to analyze effects at the programmatic level:

- **Effects of the Activity –** We review best available science and commercial information about how the activity may affect the NLEB. Based on the literature review, we identify the stressor(s) (alteration of the environment that is relevant to the species) that may result from the proposed activity. For each stressor, we identify the circumstances for an individual bat's exposure to the stressor (overlap in time and space between the stressor and a NLEB). Given exposure, we identify the likely individual response(s), both positive and negative. For this consultation, we group responses into one of four categories: (1) potentially increased fitness (e.g., increased access to, or availability of, prey organisms); (2) reduced fitness (e.g., reduced food resources, reduced suitable roosting sites); (3) disturbance (e.g., day-time disturbance in a maternity roosting area, causing bats to flee and increasing the likelihood of injury or predation); and (4) harm (e.g., harvesting a tree occupied by adults and flightless bat pups resulting in death or injury; predation resulting from disturbance). This analysis is captured in the Exposure-Response Table (Table 4.1). This table provides the complete record of the effects analysis for this species and is intended to be read in concert with and support this effects analysis section.
- **Quantifying Effects to Individuals –** Estimating the numbers of individuals of a species exposed to stressors in a programmatic consultation is difficult because programs do not usually specify with sufficient detail when and where projects will occur relative to the species' occurrence. For this consultation, we have very little site-specific data about NLEB distribution and abundance in the Action Area; however, we do not assume that the species is ubiquitous, which would grossly overestimate effects. We do not have

enough information to quantify the effects of the pathways associated with removal from human structures and the "other" category of activities that may affect the NLEB. These effects are discussed in general in the sections below. For pathways associated with timber harvest, prescribed fire, and forest conversion, we apply the annual average acreage of the activity, NLEB occupancy rates, and NLEB density within occupied areas to estimate individual-level effects (numbers of individual bats included in the pathway), which we describe in Section 4.1.2.2 below. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates, which we describe in Section 4.1.5.2 below.

We then aggregate all of the effects to individuals and examine:

- **Population-level Effects –** We evaluate the aggregated consequences of the effects to individuals/habitat on the fitness of the population(s) to which those individuals belong. This step closes with our conclusions on the likely fate or ultimate response of the population(s) and is couched in terms of population fitness (i.e., persistence and reproductive potential, long and short-term).
- **Species Range-wide** - This step determines whether the anticipated reductions in population fitness will reduce the likelihood of survival and recovery of the species by reducing its range-wide reproduction, numbers, or distribution (RND). If the Service and other action agencies have insured that the population-level risks do not noticeably, detectably, or perceivably reduce the likelihood of progressing towards or maintaining the RND needs, then the action is not likely to appreciably reduce the likelihood of both survival and recovery of the species.

4.2 REMOVAL FROM HUMAN STRUCTURES

4.2.1 EFFECTS OF REMOVAL FROM HUMAN STRUCTURES

As described in Section 2.1.1., NLEBs have occasionally been found roosting in human structures such as barns, houses, and sheds. Humans and bats often conflict when bats roost in human structures. Public misconception and health concerns from rabies, bat droppings, and urine often result in the need to remove bats from human structures. Many techniques used to remove bats are harmful and may result in mortality, including poisoning, trapping (e.g., cages, sticky traps), exterminating, and translocating (WNS Conservation and Recovery Working Group 2015). Bats can also be removed through humane methods (if used during the proper time of year) such as eviction/venting and exclusion. Eviction/venting refers to the use of one-way doors and exits to remove bats from a structure by utilizing their natural tendency to leave the roost at night. Exclusion refers to closing gaps and sealing holes to prevent bats from entering or

re-entering a structure (WNS Conservation and Recovery Working Group 2015). Eviction and exclusion are widely-used, popular methods because poisons and traps are messy and might result in dead bats rotting in walls and attics.

Table 4.1 shows the four pathways we identified for NLEB responses to removal from human structures and the range of individual responses expected. The use of rodenticides and sticky traps to remove bats is likely to result in mortality. NLEBs may also be euthanized for rabies testing. Roost closure during the maternity season has been documented to result in lower reproductive success (Brigham and Fenton 1986). Attempts to evict or exclude bats at this time can result in the death of flightless young, as well as an increase in the number of adult bats and orphaned pups that enter the living space, potentially heightening the risk of human/bat contact (WNS Conservation and Recovery Working Group 2015). In addition, NLEBs can be indirectly affected through the loss of the roost by exclusion if additional energy is required during their search for a new roost site when NLEBs return to the site after hibernation.

The WNS Conservation and Recovery Group, in coordination with states and wildlife control operators, recently developed Best Management Practices (BMPs) for bat control activities in human structures (WNS Conservation and Recovery Working Group 2015) to ensure that adverse effects are minimized. The National Wildlife Control Operators Association recently released a new training on bat standards, affecting at least 48 wildlife control operators in 20 States within the NLEB range that are Certified Wildlife Control Professionals. This certification requires training, seminars, and continued education, and we anticipate that these professionals (and probably others) will follow the bat standards.

States within the range of the NLEB vary in requirements for removal of bats from human structures. States with state- or federally-listed bat species may require permits for bat removal or may require wildlife control operators to use BMPs when removing or excluding bats from houses or structures. Within the range of the NLEB, only Maine, Montana, and the Dakotas do not have another state- or federally-listed bat species, so it is likely that many of these states already have a program to recommend or require BMPs for bat removal prior to the NLEB listing in 2014. We surveyed states to determine if: (1) wildlife control operators are required to obtain authorization for bat removal or exclusions; (2) BMPs are required or recommended; and (3) exclusions and evictions are conducted outside of the NLEB maternity season.

We were able to speak with representatives from state natural resource programs in Illinois, Wisconsin, Michigan, Missouri, Minnesota, Ohio, Vermont, and South Carolina. Five of the eight states require authorization for wildlife control operators to remove or exclude bats from buildings. Of these five states, all but Michigan require that evictions and exclusion occur after NLEB pups are capable of flight, unless in the unusual case of a severe health hazard. Even though three states do not require authorization for wildlife control operators, only two states

(Missouri and Michigan) do not communicate or recommend BMPs for bat exclusion or removals.

We also obtained rabies testing data from the state health departments in New York and Missouri. If a single or pair of bats enter a household, wildlife control operators generally trap the bats and euthanize them for rabies testing. These data indicate that an average of 7 NLEBs were killed per year for rabies testing during the most recent three years. In both New York and Missouri, NLEB make up a small fraction (typically less than 2%) of the bats in houses.

Although removal from human structures can result in NLEB mortality, we anticipate that few bats are impacted per year in each state based on the relatively rare use of human structures, the implementation of bat removal BMPs (either required or recommended) throughout most of the range of the NLEB, and the relatively small amount of NLEBs killed for rabies testing.

4.3 TIMBER HARVEST

Timber harvest is one of two categories of forest management described in this BO. Unlike forest conversion, forest management maintains forest habitat on the landscape, and the impacts from management activities are for the most part considered temporary in nature. Impacts from forest management are expected to range from positive (e.g., maintaining or increasing suitable roosting and foraging habitat within NLEB home ranges) to neutral (e.g., minor amounts forest removal, areas outside NLEB summer home ranges or away from hibernacula) to negative (e.g., death of adult females or pups or both).

Timber harvest is the removal of trees associated with forest management. It includes a wide variety of practices from selected harvest of individual trees to clearcutting. Timber harvest is often partitioned according to the forest management treatment type used to accomplish the harvest: even-aged management; uneven-aged management; thinning; and salvage/sanitation. It is conducted for a variety of purposes including, but not limited to, harvests (commercial and non-commercial) for timber production and for ecosystem restoration, endangered/threatened/sensitive species conservation, stand regeneration for forest health, wildlife habitat improvement, insect and disease control, and fuel reduction. All of these activities are categorized under the general category of timber harvest for the purposes of this BO.

4.3.1 EFFECTS OF TIMBER HARVEST

Literature Review

The best available data indicate that the NLEB shows a varied degree of sensitivity to timber-harvesting practices. Menzel et al. (2002) found NLEB roosting in intensively managed stands in West Virginia. At the same study site, Owen et al. (2002) concluded that NLEB roosted in areas with abundant snags, and that in intensively managed forests of the central Appalachians, roost availability was not a limiting factor. Perry and Thill (2007) tracked NLEB in central Arkansas and found roosts in eight different forest classes, of which 89 percent were in three classes of mixed pine-hardwood forest. The mixed pine-hardwood forest stands that supported most of the roosts were partially harvested or thinned, unharvested (50–99 years old), or harvested by group selection.

Timber harvest accomplished through thinning, group selection, and individual selection may create canopy openings in an otherwise densely-forested setting, which may promote more rapid development of bat pups. In central Arkansas, Perry and Thill (2007) found female NLEB bat roosts were more often located in areas with partial harvesting than males, with more male roosts (42 percent) in un-harvested stands than female roosts (24 percent). They postulated that females roosted in relatively more open forest conditions because they may receive greater solar radiation, which may increase developmental rates of young or permit young bats a greater opportunity to conduct successful initial flights (Perry and Thill 2007). Cryan et al. (2001) found several reproductive and non-reproductive female NLEB roosts in recently harvested (less than 5 years) stands in the Black Hills of South Dakota where snags and small stems (dbh of 5 to 15 cm (2 to 6 inches)) were the only trees left standing. In this study, however, the largest colony (n=41) was found in a mature forest stand that had not been harvested in more than 50 years. Lacki and Schwierjohann (2001) stated that silvicultural practices could meet both male and female roosting requirements by maintaining large-diameter snags, while allowing for regeneration of forests.

Forest patch size and contiguity are factors that appear to influence habitat use by NLEB. Henderson et al. (2008) observed gender-based differences in mist-net capture rates of NLEB on Prince Edward Island related to forest patch size. The area of deciduous stands had a consistent positive relationship with the probability of presence of both males and females, but males were found more often in smaller stands than females. In southeastern Missouri, Yates and Muzika (2006) reported that NLEB showed a preference for contiguous tracts of forest cover (rather than fragmented or open landscapes) for foraging or traveling, and that different forest types interspersed on the landscape increased the likelihood of occupancy.

In West Virginia, Owen et al. (2003) radio-tracked nine female NLEB that spent their foraging and travelling time in the following habitat types (in descending order of use):

- 70–90-year-old stands without harvests in more than 10–15 years (“intact forest”) (mean use 52.4 percent);

- 70–90 year-old stands with 30–40 percent of basal area removed in the past 10 years ("diameter-limit harvests") (mean use 42.9 percent);
- open areas (clearcuts and roads) (clear cut = all trees > 2.5 cm (1.0 inch) dbh removed) (mean use 4.6 percent); and
- clearcuts with approximately 4.5 m^2/ha (19.6 ft^2/acre) tree basal area remaining ("deferment harvests") (mean use 0.03 percent).

Habitat selection differed significantly relative to habitat availability, with diameter-limit harvests ranking as the strongest habitat preference, where percent use exceeded percent availability for 7 of the 9 bats.

In Alberta, Canada, NLEB avoided the center of clearcuts and foraged more in intact forest than expected (Patriquin and Barclay 2003). On Prince Edward Island, Canada, female NLEB preferred to forage in areas centered along creeks running through forests (Henderson and Broders 2008). In mature forests on the Sumter National Forest in northwestern South Carolina, 10 of the 11 stands in which NLEB were detected were mature stands (Loeb and O'Keefe 2006). Within those mature stands, NLEB were recorded more often at points with sparse or medium-density vegetation than at points with dense vegetation, suggesting that small openings within forest stands facilitate commuting and/or provide suitable foraging habitat. However, in southwestern North Carolina, Loeb and O'Keefe (2011) found that NLEB rarely used forest openings, but often used roads.

At Fort Knox in Kentucky, Silvis et al. (2014) tracked three maternity colonies of NLEB to evaluate their social and resource networks, i.e., roost trees. Roost and social network structure differed between maternity colonies, and roost availability was not strongly related to network characteristics or space use. In model simulations based on the tracking data, removal of more than 20 percent of roosts initiated social network fragmentation, with greater loss causing more fragmentation. The authors suggested that flexible social dynamics and tolerance of roost loss are adaptive strategies for coping with ephemeral conditions in dynamic forest habitats. Sociality among bats may contribute to reproductive success, and fragmented colonies may experience reduced success.

In the same Fort Knox study area with the same three maternity colonies, Silvis et al. (2015) removed during winter a primary maternity roost tree from one colony, 24 percent of the secondary roosts from another colony, and none from the third. Neither removal treatment altered the number of roosts used by individual bats, but secondary roost removal doubled the distances moved between sequentially used roosts. Overall location and spatial size of colonies was similar pre- and post-treatment. Patterns of roost use before and after removal treatments also were similar. Roost height, diameter at breast height, percent canopy openness, and roost species composition were similar pre- and post-treatment. NLEB use a wide range of tree species and sizes as roosts, and potential roosts were not limited in the treatment areas.

Although the literature we reviewed contains no reports of NLEB mortality resulting from tree harvest, there have been three documented instances of Indiana bat adults and pups killed or injured when an occupied roost tree was felled. Indiana bats and NLEB are closely related and have similar behavior (i.e., forest-dwelling, forming maternity colonies, roosting in trees in the summer). Cope et al. (1974) reported the first felling of an occupied Indiana bat maternity roost tree in Wayne County, Indiana. The landowner observed bats exiting the tree when it was bulldozed down. The original account stated that eight bats (2 adult females and 6 juveniles) were "captured and identified as Indiana bats," and that about 50 bats flew from the tree. Although the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State University, pers. comm., 2005) recounted that those bats were killed or disabled, retrieved by the landowner, and subsequently identified by a biologist. In another case, Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio. One dead adult female and 33 non-volant young were retrieved by the researcher. Three of the young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved by adult bats that had survived. In a third case, 11 dead adult female Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005).

These accounts suggest that some individuals, including non-volant pups, can survive the felling of a maternity roost tree. It is not possible to infer injury rates from these studies. It is only possible to crudely estimate mortality rates from the Belwood case. If we assume that there were 66 individuals in the tree (the 33 pups observed plus 1 dead adult female and 32 presumed additional adult females who retrieved their pups), the overall survival rate was high at 91%. Only 1 adult bat was observed dead (about 3% of adults), and the juvenile mortality rate was about 15%. We acknowledge that timber harvest operations in a forest bear little resemblance to these three instances, but available evidence indicates that both adults and pups can be killed when an occupied roost tree is felled. For the purposes of this consultation, we assume that 15% of non-volant bats have the potential to be harmed, and 3% of adult bats could be killed or injured in a felled tree. Adults may be at greater risk during the spring during colder temperatures and increased use of torpor. It is also possible that trees felled adjacent to roost trees could strike roosting bats and result in injury or death.

Disturbance associated with harvest activity could cause NLEB to flee or abandon day-time roosts, which increases the likelihood of predation. This may also result in females aborting or not being impregnated depending on the time of year. Gardner et al. (1991) reported that Indiana bats continued to roost and forage in an area with active timber harvest, but this will depend on the scale of harvest and whether there is any remaining suitable habitat. Callahan (1993) attributed the abandonment of a primary maternity roost tree to disturbance from a bulldozer clearing brush adjacent to the tree.

Surface-disturbing activities in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003). Tree removal in karst areas can alter soil characteristics, water quality, local hydrology to the extent that it alters cave microclimates and affects bats (Bilecki 2003, Hamilton-Smith 2001). Bats in hibernation are susceptible to dehydration due to high evaporative loss from their naked wings and large lungs (Perry 2013). Richter et al. (1993) documented temperature increases resulting from structural modifications to a cave entrance that substantially reduced its suitability for bats. The creation of new openings or filling in existing openings could also result from obstructing cave entrances with dirt or logging slash.

Summary of Exposure-Response Table

Table 4.1 shows the five pathways we identified for NLEB responses to timber harvest and the range of individual responses expected. The primary alteration of the environment associated with timber harvest that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies harvest activities may result in disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. Thinning mid-story clutter may have a beneficial effect on the suitability of adjacent maternity roost trees when done when bats are not present. The species' responses to these stressors depends on the type of harvest (e.g., thinning, salvage, even-aged management, clear cut, etc.) and the context of exposure, i.e., when and where it occurs.

4.3.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF TIMBER HARVEST

To estimate the potential impacts of timber harvest through 2022, we calculated the average annual amount of timber harvest in states within the NLEB's range using data available through the USDA Forest Service's Forest Inventory Analysis (available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp; accessed November 2015). This database reports the total harvest (acres) of federal, state and local, and private entities by state for various combinations of years. We used the most recent combination of years available and calculated the mean annual harvest (Table 4.2). We assumed that the mean annual harvest from recent years will be consistent through the period of this consultation and recognize that many types of harvest leave a remaining forest that is available for NLEB use. The information in this database may be overestimated for certain states and underestimated for others. For instance, we estimated that 163,971 acres would be harvested on average in National Forests in South Dakota; however, the U.S. Forest Service is currently projecting up 35,000 acres of harvest annually. In Illinois, the

database reports 0 acres of harvest, but the Forest Service projects 1,300 acres of average annual harvest.

Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. These estimates are likely conservative and underestimate the number of acres harvested; however, some harvest reports may reflect a few tree removals and not necessarily a clear cut or selected harvest. We anticipate that 3,669,077 acres will be harvested annually through 2022, which is 1.3% of the available forested habitat, or 9.1% over seven years (Table 4.2). Timber harvest is expected to occur in similar proportions in the Midwest, Eastern, and Southern ranges (29, 35, and 34%, respectively), but only about 2% of the total harvest will occur in the Western range. We anticipate that habitat losses from timber harvest will be temporary.

We further analyzed these data by partitioning the average annual acreage expected during the NLEB active season and the pup season. Lacking a breakdown of the acres harvested during the active and non-volant seasons, we assume that timber harvest will occur with equal frequency throughout the year. The NLEB active season (April 1 – October 31) is 214 days, or 58.6% of the year. The NLEB non-volant season (June 1 – July 31) is 61 days, or 16.7% of the year. Therefore, the average annual acres of timber harvest during the active season is 58.6% of the total average annual acres, and 16.7% of the total timber harvest is estimated to occur in the non-volant season.

For spatial exposure to stressors, we must consider that timber harvest and NLEB-occupied areas may occur anywhere within the forested acreage of each state, but we recognize there are some forests in National or State Parks or Wilderness areas that may not be subject to harvest. NLEB occupancy estimates vary by state from about 9 to 60 percent (see section 2.4.1). It is possible for timber harvest, which annually affects about 1.3 percent of the available forested habitat, to occur entirely on the 5 to 65 percent of the habitat in each state that we consider occupied, or not at all, because we have no information indicating whether certain activities are more or less likely to occur in occupied areas. Therefore, our effects analyses compute the expected (probable) degree of spatial overlap between activities and occupied areas as the product of two independent probabilities, namely, the percentage of the forested habitat that is proposed for timber harvest multiplied by the percentage of the forested habitat that the NLEB occupies in a particular manner, e.g., for roosting or foraging.

The following example demonstrates our methodology for estimating individual-level direct effects corresponding to the stressor-exposure-response pathway for timber harvest during the non-volant season (June 1–July 31) within a maternity roost, which may kill or injure non-volant pups.

a. State A, with 500,000 acres of forested habitat, will annually harvest 2,500 acres (0.5 percent of the total habitat) during the non-volant season.
b. State A has a 30 percent occupancy rate for NLEB, i.e., 150,000 acres of State A are within the active-season home range of individuals of this species.
c. We assume that individuals belonging to maternity colonies collectively occupy 90 percent (co-capture rate of reproductive females with males and non-reproductive females; see section 2.4 for the basis of this and other NLEB distribution and abundance assumptions) of these 150,000 acres, or 0.90 × 150,000 = 135,000 acres.
d. We assume maternity colonies do not overlap and occupy 1,000 acres each; therefore State A supports 135,000 ÷ 1,000 = 135 colonies.
e. We assume that individuals in a maternity colony roost in trees within an area of 167 acres; therefore, the colonies of State A occupy 135 × 167 acres = 22,545 acres for roosting, which is 4.5 percent of State A.
f. State A has not yet been affected by WNS; therefore, each colony supports 45 non-volant pups during the harvest time frame (1 pup per adult female, section 2.4).

In this example, 2,500 acres (0.5 percent) of the forested acres in the state are proposed for harvest during the non-volant season, and 22,545 acres (4.5 percent) harbors non-volant pups. The mathematically expected (probable) degree of spatial overlap is the product of the two percentages, or 0.5 percent × 4.5 percent = 0.0225 percent, which is 112.7 acres of the 500,000 acres in State A. To estimate the number of bat pups affected, we multiply the density of bat pups in maternity roosting areas (45 pups per 167 acres) by the expected acreage of overlap: (45 ÷ 167) × 112.7 = 30.3, which we round up to 31 pups. We aggregate the results of this type of analysis for all timber harvest actions within a state and across all 30 states included in the analysis, which provides a basis for estimating the total expected effects of multiple project-level actions at a scale not exceeding the total amount of timber harvest estimated per year.

Consistent with the example above, our calculations for estimating the effects corresponding to each stressor-exposure-response pathway that we quantify are presented in tabular form in section 4.3. Each table lists the 30 states with the following six columns of data:

a. annual, active-season, or non-volant-season extent (acres) of timber harvest (or the proposed activity causing the stressor), depending on the pathway;
b. total forest habitat acres;
c. percent of the forest habitat receiving the activity (a ÷ b);
d. percent of the forest habitat that NLEB use at a time and in a manner (from section 2.4) that the stressor could affect causing a specific type of individual response;
e. expected overlap (acres) of the activity and the bat-occupied area (b × c × d); and
f. expected number of individuals affected (e × bat density in the occupied area).

In the final step of the calculations described above, the density we multiply by the expected area of overlap depends on the manner in which NLEB use the habitat exposed to the stressor. In the

preceding example, non-volant pups in maternity roosting areas are the individuals responding to the stressor, and the density is 45 pups per 167 acres (0.2695). Based on the data and assumptions identified in section 2.4 about NLEB populations in the Action Area, we use the following NLEB densities in computing column "e" of each effects estimation table:

Habitat	NLEB individuals	Density for 45 females per Maternity Colony	Density for 39 females per Maternity Colony	Density for 20 females per Maternity Colony
Summer home range	Adult females and sympatric adult males	0.0814	0.0362	0.0705
Maternity roosting areas	Non-volant pups	0.2695	0.1198	0.2335
Roosting areas	Adult females, volant juveniles, and sympatric adult males	0.8084	0.3593	0.7006

This methodology generates results in terms of numbers of individual NLEB affected, but we must acknowledge its inherent imprecision. It relies on assumptions about state-specific occupancy rates and applies values for colony size, sex ratios, etc., that we believe are reasonable and based on best available information, but which are either uncertain or variable across the Action Area. Although it is coarse, this methodology provides a transparent basis for quantifying effects for interpretation relative to the status of the species, which is the purpose of an effects analysis in a BO.

4.3.3 QUANTIFYING EFFECTS OF TIMBER HARVEST

We quantify the two pathways expected to result in direct effects to the NLEB: disturbance from fleeing human activity (Table 4.3), and harm from removing occupied roost trees (Table 4.4 for pups and Table 4.5 for adults). Human disturbance from timber harvest during the active season (April – October) within maternity roosting areas may disturb up to 76,846 volant NLEB annually (Table 4.3). A small subset of these disturbed individuals may be harmed. Timber harvests that remove occupied roost trees during the non-volant season may harm up to 1,109 pups annually (Table 4.4). Removal of occupied roost trees during the active season may harm up to 247 adults annually (Table 4.5).

In addition to these two pathways, timber harvest activities could alter the flow of air and water through unknown hibernacula which could also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed (i.e., not concentrated in a given area) nature of timber harvest activities. In addition, the hibernacula often selected by NLEB are "large, with large passages" (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from timber

harvest around unknown roosts. Further, bats rarely hibernate near the entrances of structures (Grieneisen 2011). Davis et al (1999) reported that partial clearcutting "appears not to affect winter temperatures deep in caves."

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 1.3% (3,669,077 acres) of available habitat will be harvested annually through 2022; however, we anticipate that habitat losses from timber harvest will be temporary. In addition, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada's Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, timber harvest practices that reduce mid-story clutter likely also benefit NLEB habitat and may increase fitness of local NLEB populations. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.4 PRESCRIBED FIRE

Prescribed fire is the other category of forest management described in this BO. Prescribed burning is deliberately burning wild-land fuels under specified environmental conditions in a predetermined area with a predetermined fire-line intensity and rate of movement in order to attain resource management objectives. It is typically classified as dormant-season and growing-season burning. The seasonality varies by latitude and elevation, but the dormant season is generally October –April and the growing season is April 15 – August 15. Dormant-season burning is primarily used to reduce the buildup of hazardous fuels and thereby reduce the likelihood of catastrophic wildfires or to achieve ecological stand objectives. Growing-season burning is used for site preparation, control of undesirable species, and restoration and maintenance of fire-dependent plant communities and associated wildlife. Most growing season burning takes place in the spring and fall; however, growing season burning occurs through the active and pup seasons in the rest of the range. For example, we recently completed programmatic consultations for the NLEB with the U.S. Forest Service on Forest Plans in their Southern and Eastern regions, which includes the Midwest, Southern, and Eastern ranges of the NLEB. Twenty-one and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively.

4.4.1 EFFECTS OF PRESCRIBED FIRE

Literature Review

Perry (2012) provides a review of fire effects on bats in the eastern oak region of the U.S., and Carter et al. (2002) provides a similar review for bats in the southeastern and mid-Atlantic states. Forest-dwelling bats, including the wide-ranging NLEB, were presumably adapted to the fire-driven disturbance regime that preceded European settlement and fire suppression in many parts of the eastern U.S. Concurrent changes in habitat conditions preclude any reasonable inferences about the overall impact of fire suppression on populations of forest-dwelling bats. It is apparent that fire may affect individual bats directly (negatively) through exposure to heat, smoke, and carbon monoxide, and indirectly (both positively and negatively) through habitat modifications and resulting changes in their food base (Dickinson et al. 2009).

Direct Effects – Summer Roosting

Little is known about the direct effects of fire on cavity and bark roosting bats, such as the NLEB, and few studies have examined escape behaviors, direct mortality, or potential reductions in survival associated with effects of fire. Dickinson et al. (2009) monitored two NLEB (one male and one female) in roosts during a controlled summer burn. Within 10 minutes of ignition near their roosts, both bats flew to areas that were not burning. Among four bats they tracked before and after burning, all switched roosts during the fire, with no observed mortality. Rodrigue et al. (2001) reported flushing a *Myotis* bat from an ignited snag during an April controlled burn in West Virginia.

Carter et al. (2002) suggested that the risk of direct injury and mortality to southeastern forest-dwelling bats resulting from summer prescribed fire is generally low. During warm temperatures, bats are able to arouse from short-term torpor quickly. Most adult bats are quick, flying at speeds > 30 km/hour (Patterson and Hardin 1969), enabling escape to unburned areas. NLEB use multiple roosts, switching roost trees often (see *Summer Roosting Behavior* in Section 2.4.3), and could likely use alternative roosts in unburned areas, should fire destroy the current roost. Non-volant pups are likely the most vulnerable to death and injury from prescribed fire. Although most eastern bat species are able to carry their young for some time after they are born (Davis 1970), the degree to which this behavior would allow females to relocate their young if fire threatens the nursery roost is unknown.

Dickinson et al. (2010) used a fire plume model, field measurements, and models of carbon monoxide and heat effects on mammals to explore the risk to the Indiana bat and other tree-roosting bats during prescribed fires in mixed-oak forests of southeastern Ohio and eastern Kentucky. Carbon monoxide levels did not reach critical thresholds that could harm bats in low-

intensity burns at typical roosting heights for the Indiana bat (8.6 m) (28.2 ft). NLEB roost height selection is more variable, but on average lower (6.9 m) (22.8 ft) than the Indiana bat (Lacki et al. 2009b). In this range of heights, direct heat could cause injury to the thin tissue of bat ears. Such injury would occur at roughly the same height as tree foliage necrosis (death) or where temperatures reach 60 °C (140 °F). Most prescribed fires for forest management are planned to avoid significant tree scorch.

Direct and Indirect Effects – Winter Roosting

Little is known about the direct effects of fire on bats in adjacent caves and mines. Smoke and noxious gases could enter caves and mines, depending on airflow characteristics and weather conditions (Carter et al. 2002; Perry 2011). Although smoke from winter fires may not reach toxic levels in caves and mine, introduced gases could arouse bats from hibernation, causing energy expenditure and reduced fitness (Dickinson et al. 2009). Caviness (2003) observed smoke intrusion into hibernacula during winter burning in Missouri, but did not observe any bat arousal. Fire could alter vegetation surrounding the entrances to caves and mines, which could indirectly affect temperature and humidity regimes of hibernacula by modifying airflow (Carter et al. 2002, Richter et al. 1993).

Indirect Effects – Roost Availability/Suitability

Fire can affect the availability of roosting substrate (cavities, crevices, loose bark) by creating or consuming snags, which typically provide these features, or by creating these features in live trees. Although stand-replacing or intense wildfires may create large areas of snags, the effects of multiple, low-intensity prescribed burning on snag dynamics are less obvious, especially for forests consisting mostly of fire-adapted species. Low-intensity, ground-level fire may injure larger hardwood trees, creating avenues for pathogens such as fungi to enter and eventually form hollow cavities in otherwise healthy trees (Smith and Sutherland 2006). Fire may scar the base of trees, promoting the growth of basal cavities or hollowing of the bole in hardwoods (Nelson et al. 1933, Van Lear and Harlow 2002). Repeated burning could potentially create forest stands with abundant hollow trees. Trees located near down logs, snags, or slash may be more susceptible to damage or death, and aggregations of these fuels can create clusters of damaged trees or snags (Brose and Van Lear 1999, Smith and Sutherland 2006).

Bats are known to take advantage of fire-killed snags and continue roosting in burned areas. Boyles and Aubrey (2006) found that, after years of fire suppression, initial burning created abundant snags, which evening bats (*Nycticeius humeralis*) used extensively for roosting. Johnson et al. (2010) found that after burning, male Indiana bats roosted primarily in fire-killed maples. In the Daniel Boone National Forest, Lacki et al. (2009a) radio-tracked adult female NLEB before and after prescribed fire, finding more roosts (74.3 percent) in burned habitats than

in unburned habitats. Burning may create more suitable snags for roosting through exfoliation of bark (Johnson et al. 2009a), mimicking trees in the appropriate decay stage for roosting bats.

In addition to creating snags and live trees with roost features, prescribed fire may enhance the suitability of trees as roosts by reducing adjacent forest clutter (see *Canopy Cover/Closure* in Section 2.4.3). Perry et al. (2007) found that five of six species, including NLEB, roosted disproportionally in stands that were thinned and burned 1-4 years prior but that still retained large overstory trees. Boyles and Aubrey (2006) found evening bats used burned forest exclusively for roosting.

Indirect Effects – Summer Foraging

Adult insects are the predominant prey of NLEB (see Section 2.2.4 Foraging Behavior). On the Daniel Boone National Forest, Lacki et al. (2009a) found that abundance of coleopterans (beetles), dipterans (flies), and all insects combined captured in black-light traps increased following prescribed fires. The mechanism of this increase is presumably the new growth of ground vegetation that a burn stimulates. In fecal samples of NLEB, lepidopterans (moths), coleopterans, and dipterans were the three most important groups of insect prey, with dipteran consumption increasing after burning. NLEB appeared to track the observed changes in insect availability, i.e., home ranges were closer to burned habitats following fires than to unburned habitats, but home range size did not vary before and after fires.

<u>Summary of Exposure-Response Table</u>

Table 4.1 shows the eight pathways we identified for NLEB responses to prescribed fire and the range of individual responses expected. In general, exposure to prescribed burning can cause direct adverse responses (disturbance, injury, death) and indirect adverse and beneficial responses via changes to roosting and foraging resources and forest health maintenance. Stressors caused by burning include heat and smoke during the actual movement of a fire through forested areas and fire-induced changes in vegetation structure and composition. Bat exposure to these direct and indirect stressors depends on timing of the burn and how bats may use the burned area, e.g., for roosting, foraging, spring staging, fall swarming, or hibernation in a cave/mine where the entrance is within or near the burned area.

4.4.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF PRESCRIBED FIRE

To estimate the potential impacts of prescribed fire through 2022, we compiled the mean, minimum, and maximum acres of prescribed burns in each state from 2002 to 2014 (Table 4.6) using data available through the National Interagency Fire Center (available on internet: https://www.nifc.gov/fireInfo/fireInfo_stats_prescribed.html; accessed November 2015). We

assumed the mean annual use of prescribed fire from 2002-2014 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range.

These data represent the total amount of prescribed burning in each state without regard to habitat type. We further parsed these data using information from the 2012 National Prescribed Fire Use Survey Report (Melvin 2012) to exclude burned grassland habitats as these are not relevant to the NLEB. The burn report estimated the percent of prescribed fire used to manage grassland or agriculture habitat and forested land in 2012. We recognize that this percentage likely varies to some degree every year, but we assume that the proportion of prescribed fire in forested habitat is similar. We use the mean annual acres of prescribed fire in forested habitat reported in Table 4.6 for the purposes of this BO. We anticipate that 648,908 acres will be burned annually through 2022, which is 0.2% of the available forested habitat (Table 4.2). The majority of prescribed burning is expected to occur in the Southern range (64%), followed by 29% in the Midwest, 4% and 3% in the Eastern and Western ranges, respectively.

Similar to timber harvest, we lack a breakdown of the acres burned during the active and non-volant seasons, and we assume that prescribed burning will occur with equal frequency throughout the year. Therefore, the average annual acres of prescribed burning during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season. This estimate is similar to the recent estimates from programmatic consultations for the NLEB on U.S. Forest Service lands, where 21 and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively. This may be an overestimate for the western range.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.4.3 QUANTIFYING EFFECTS OF PRESCRIBED FIRE

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing the fire (Table 4.7), and harm to pups from heat and smoke during the non-volant season (Table 4.8). Prescribed fires during the active season within maternity roosting areas may disturb up to 19,417 volant NLEB annually through fleeing and increased predation (Table 4.7). A small subset of disturbed individuals may be harmed. Prescribed burning during the non-volant season may harm up to 1,859 pups annually (Table 4.8).

In addition to these two pathways, prescribed burning could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula may occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of prescribed burning. In addition, Caviness (2003) reported that prescribed burns were found to have no notable influence on bats hibernating in various caves in the Ozark National Forest. All bats present in caves at the beginning of the burn were still present and in "full hibernation" when the burn was completed, and bat numbers increased in the caves several days after the burn. There were minute changes in relative humidity and temperature during the burn and elevated short-term levels of some contaminants from smoke were noted.

We also do not quantify the potential reductions or increases in fitness that may result as indirect effects from the loss of roost trees (adverse) or the creation of roost trees, increased prey availability, or reduction of mid-story clutter (beneficial). We anticipate that only 0.2% of available habitat will be burned annually, and any habitat losses from prescribed fire will be temporary. In addition, the NLEB does not appear to be limited by roost trees, as demonstrated through a great deal of plasticity within its environment (e.g., roosting in a wide variety of trees and sizes). Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, prescribed fire likely also benefits NLEB habitat and may increase fitness of local populations as described above. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.5 FOREST CONVERSION

Forest conversion is the loss of forest to another land cover type (e.g., grassland, cropland, development). For the purposes of this BO, we define forest conversion as any activity that removes forested habitat that is suitable for the NLEB. This includes, but is not limited to, tree removal from commercial or residential development, energy production and transmission (oil, gas, solar, wind), mining, agriculture, transportation, military training, and other ecosystem management. Unlike forest management, forest conversion permanently removes forested habitat on the landscape, or in some cases, there is no forest for decades as in the case of mining.

4.5.1 EFFECTS OF FOREST CONVERSION

In the final listing rule for the NLEB, we note that forest conversion could result in the following impacts: (1) loss of suitable roosting or foraging habitat; (2) fragmentation of remaining forest patches, leading to longer flights between suitable roosting and foraging habitat; (3) removal of (fragmenting colonies/networks) travel corridors; and (4) direct injury or mortality from the removal of occupied roosts during active season clearing. Forest conversion could also alter the flow of air and water through unknown hibernacula and impact NLEBs.

The literature review for timber harvest describes the loss of suitable roosting or foraging habitat, direct injury or mortality from removal of occupied roost, and alteration of hibernacula (see section 4.1.2.1). Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption. NLEBs emerge from hibernation with their lowest annual fat reserves and return to their summer home ranges. Because NLEBs have summer home range fidelity (Foster and Kurta 1999; Patriquin et al. 2010; Broders et al. 2013), loss or alteration of forest habitat may put additional stress on females when returning to summer roost or foraging areas after hibernation. Females (often pregnant) have limited energy reserves available for use if forced to seek out new roosts or foraging areas. Hibernation and reproduction are the most energetically demanding periods for temperate-zone bats, including the NLEB (Broders et al. 2013). Bats may reduce metabolic costs of foraging by concentrating efforts in areas of known high prey profitability, a benefit that could result from the bat's local roosting and home range knowledge and site fidelity (Broders et al. 2013). Cool spring temperatures provide an additional energetic demand, as bats need to stay sufficiently warm or enter torpor. Entering torpor comes at a cost of delayed parturition; bats born earlier in the year have a greater chance of surviving their first winter and breeding in their first year of life (Frick et al. 2010). Delayed parturition may also be costly because young of the year and adult females would have less time to prepare for hibernation (Broders et al. 2013). Female NLEBs typically roost colonially, with their largest population counts occurring in the spring (Foster and Kurta 1999), presumably as one way to reduce thermal costs for individual bats (Foster and Kurta 1999). Therefore, similar to other temperate bats, NLEBs have multiple high metabolic demands (particularly in spring) and must have sufficient suitable roosting and foraging habitat available in relatively close proximity to allow for successful reproduction.

Table 4.1 shows the six pathways we identified for NLEB responses to forest conversion and the range of individual responses expected. The primary alteration of the environment associated with forest conversion that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Fragmentation and loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies conversion activities may result in

disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. The species' responses to these stressors depend on the timing, location, and extent of the removal. In areas with little forest or highly fragmented forests (e.g., western U.S. edge of the range, central Midwestern states; see Figure 1.1, above), impact of forest loss would be disproportionately greater than similar-sized losses in heavily forested areas (e.g., Appalachians and northern forests). Also, the impact of habitat loss within a NLEB's home range is expected to vary depending on the scope of removal.

4.5.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF FOREST CONVERSION

To estimate the potential impacts of forest conversion through 2022, we examined the total forested acres in each state from 2001 to 2011 using the National Land Cover Datasets (Homer et al. 2015). We calculated the approximate acres of forest lost per state per year by subtracting the acres of total forest in 2011 from the forested acres in 2001 and calculating the annual loss over the 10 year period (Table 4.9). We assume that the mean annual forest conversion from 2001-2011 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. We anticipate that 914,237 acres will be converted from forested habitat annually through 2022, which is 0.3% of the available forested habitat per year and 2.3% of the available habitat through 2022 (Table 4.2). The majority of the expected forest conversion will occur in the Southern range (53%), followed by the Eastern range (26%), Midwest (19%). Only about 2% of the total conversion will occur in the Western range.

Similar to timber harvest, we lack a breakdown of forest conversion during the active and non-volant seasons, and we assume that it will occur with equal frequency throughout the year. Therefore, the average annual acres of forest conversion during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.5.3 QUANTIFYING EFFECTS OF FOREST CONVERSION

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing human activity (Table 4.10), and harm from removing occupied roost trees (Table 4.11 for pups

and Table 4.12 for adults). Human disturbance from forest conversion during the active season (April – October) within maternity roosting areas may disturb up to 21,004 volant NLEB annually (Table 4.10). Forest conversion activities that remove occupied roost trees during the non-volant season may harm up to 317 pups annually (Table 4.11). Removal of occupied roost trees during the active season may harm up to 83 adults annually (Table 4.12).

In addition to these two pathways, forest conversion could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of forest conversion activities. In addition, the hibernacula often selected by NLEB are "large, with large passages" (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from forest conversion around unknown roosts. Raesly and Gates (1987) evaluated external habitat characteristics of hibernacula and reported that for the NLEB the percentage of cultivated fields within 0.6 miles (1 km) the hibernacula was greater (52.6 percent) for those caves used by the species, than for those caves not used by the species (37.7 percent), suggesting that the removal of some forest around a hibernacula can be consistent with the species needs.

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 0.3% (914,237 acres) of available habitat will be converted annually through 2022. We anticipate that habitat losses from forest conversion will be permanent. However, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada's Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small.

4.6 WIND TURBINE OPERATION

Wind energy development is rapidly increasing throughout the NLEB's range. Iowa, Illinois, Oklahoma, Minnesota, Kansas, and New York are within the top 10 States for wind energy capacity (installed megawatts) in the United States (AWEA 2013). There is a national movement towards a 20 percent wind energy sector in the U.S. market by 2030 (United States Department of Energy (US DOE) 2008). Through 2012, wind energy has achieved its goals in installation towards the targeted 20 percent by 2030 (AWEA 2015a). If the target is achieved, it would represent nearly a five-fold increase in wind energy capacity during the next 15 years (Loss et al. 2013). While locations of future wind energy projects are largely influenced by ever-changing economic factors and are difficult to predict, sufficient wind regimes exist to support wind power

development throughout the range of the NLEB (USDOE 2015a), and wind development can be expected to increase throughout the range in future years. Wind energy facilities have been constructed in areas within a large portion of the range of the NLEB.

4.6.1 EFFECTS OF WIND TURBINE OPERATION

Significant bat mortality has been witnessed associated with utility-scale (greater than or equal to 0.66 megawatt (MW)) wind turbines along forested ridge tops in the eastern and northeastern United States and in agricultural areas of the Midwest (Johnson 2005; Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013; Hayes 2013; Smallwood 2013). Recent estimates of bat mortality from wind energy facilities vary considerably depending on the methodology used and species of bat. Arnett and Baerwald (2013) estimated that 650,104 to 1,308,378 bats had been killed at wind energy facilities in the United States and Canada as of 2011, and expected another 196,190 to 395,886 would be lost in 2012. Other bat mortality estimates range from "well over 600,000… in 2012" (Hayes 2013; [but see Huso and Dalthorp 2014]) to 888,000 bats per year (Smallwood 2013), and mortality can be expected to increase as more turbines are installed on the landscape. The majority of bats killed include migratory foliage-roosting species the hoary bat (*Lasiurus cinereus*) and eastern red bat, and the migratory, tree- and cavity-roosting silver-haired bat (Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013). NLEBs are rarely detected as mortalities, even in areas where they are known to be common on the landscape.

The Service reviewed post-construction mortality monitoring studies at 62 unique operating wind energy facilities in the range of the NLEB in the United States and Canada. In these studies, 41 NLEB mortalities were documented, comprising less than 1 percent of all bat mortalities. Northern long-eared bat mortalities were detected throughout the study range at 29 percent of the facilities, including: Illinois, Indiana, Maryland, Michigan, Missouri, New York, Pennsylvania, West Virginia, and Ontario. There is a great deal of uncertainty related to extrapolating these numbers to generate an estimate of total NLEB mortality at wind energy facilities due to variability in post-construction survey effort and methodology (Huso and Dalthorp 2014). Bat mortality can vary between years and between sites, and detected carcasses are only a small percentage of total bat mortalities. Despite these limitations, Arnett and Baerwald (2013) estimated that wind energy facilities in the United States and Canada killed between 1,175 and 2,433 NLEBs from 2000 to 2011.

There are three impacts of wind turbines that may explain proximate causes of bat fatalities, which include: (1) bats collide with turbine towers; (2) bats collide with moving blades; or (3) bats suffer internal injuries (barotrauma) after being exposed to rapid pressure changes near the trailing edges and tips of moving blades (Cryan and Barclay 2009). Researchers have recently indicated that traumatic injury, including bone fractures and soft tissue trauma caused by collision with moving blades, is the major cause of bat mortality at wind energy facilities

(Rollins et al. 2012; Grodsky et al. 2011). Grodsky et al. (2011) suggested that these injuries can lead to an underestimation of bat mortality at wind energy facilities due to delayed lethal effects. However, the authors also noted that the surface and core pressure drops behind the spinning turbine blades are high enough (equivalent to sound levels that are 10,000 times higher in energy density than the threshold of pain in humans) to cause significant ear damage to bats flying near wind turbines (Grodsky et al. 2011). Bats suffering from ear damage would have a difficult time navigating and foraging, as both of these functions depend on the bats' ability to echolocate (Grodsky et al. 2011). While earlier papers indicated that barotrauma may also be responsible for a considerable portion of bat mortality at wind energy facilities (Baerwald et al. 2008), in a more recent study, researchers found only 6 percent of wind turbine killed bats at one site were possibly killed by barotrauma (Rollins et al. 2012). In a separate study, Grodsky et al. (2011) found that 74 percent of carcasses had bone fractures and more than half had mild to severe hemorrhaging in the middle or inner ears; thus it is difficult to attribute individual fatalities exclusively to either direct collision or barotrauma.

Table 4.1 shows the two pathways we identified for NLEB responses to wind turbine operation and the range of individual responses expected. The primary impact to bats from operation of wind facilities is death resulting from collision with operating turbines. It is also possible that NLEBs could be disturbed by sound from turbine operation; however, studies have found no evidence to suggest that bats are likely to be affected (Szewczak and Arnett 2006; Horn et al. 2008). We do not address sound from turbine operation further in this BO. We include the potential impacts from construction under forest conversion.

4.6.2 QUANTIFYING EFFECTS OF WIND TURBINE OPERATION

This section describes the approach for determining the current and future wind energy development conditions and the estimation of potential fatalities from wind energy through the duration of this consultation in 2022.

We compiled the installed wind power capacity (megawatts [MW]) as identified by the American Wind Energy Association (AWEA) for each state within the NLEB's range through 2014 (AWEA 2014). Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. There is currently no installed wind power capacity in the excluded states of Louisiana, Alabama, Georgia, and South Carolina, but there was 5,857 MW of installed capacity in Montana, Wyoming, and Oklahoma as of 2014. To determine if excluding these states was reasonable, we also examined a wind development pressure map (Figure 4.1) developed using the Federal Aviation Administration's wind turbine data (Service 2015a, unpublished data). We concluded that a small amount of potential wind energy development was within the species' range in Montana, Wyoming, and Oklahoma; however, the inclusion of the full states of Nebraska and Kansas should compensate

for any impacts not included in the excluded states. The total amount of installed wind capacity for the remaining states within the range of the NLEB was 28,294 MW at the end of 2014 (Table 4.13).

To estimate the potential impacts of future wind energy development through 2022, we used the Department of Energy's 2020 and 2030 build-out projections from the interactive map developed using data from with their 2015 Wind Vision Report (http://energy.gov/maps/map-projected-growth-wind-industry-now-until-2050; USDOE 2015b). The total amount of installed wind capacity by 2020 for states with more than 50% of their area within the NLEB range is projected to be 44,100 MW (Table 4.13). Lacking annual projections, we assumed that the annual build-out from 2014 to 2020 would be the mean of the total build-out over the six year period. We estimated build-out in 2021 and 2022 by taking the difference between the 2030 and 2020 projections and assuming the annual build-out in 2021 and 2022 would be the mean of the total build-out through 2030. The total amount of installed wind capacity by 2022 for states with more than 50% of their area within the NLEB range is projected to be 55,006 MW. The total capacity of wind energy is anticipated to nearly double in the next seven years.

The best source of information available to estimate anticipated future impacts to bats from collision with wind turbines is data from post-construction monitoring studies of existing wind facilities. Species composition data from these studies can be used to estimate the level of NLEB mortality by assuming the proportion of documented fatalities of NLEB, relative to the fatalities of all other bat species, represents the proportion of NLEB fatalities expected in other projects situated in similar geographic areas. It is important to use data that are as representative as possible of the conditions in the area for which mortality is being estimated because multiple variables are likely to influence mortality rates at wind energy facilities, including location relative to bat areas of activity, turbine height, rotor-swept area, turbine cut-in speed (i.e., the minimum speed required to produce energy), geographic location, elevation, topographic location, surrounding habitat types, time of year, and weather conditions. Uncertainty regarding variations in the relative densities of different species of bats across the landscape and over time are an additional source of error in this estimation. However, we used the data from the draft Midwest Wind Energy Habitat Conservation Plan (MWE HCP) as a surrogate for the full range of the species because the post construction mortality studies have not been compiled at the range-wide scale of the NLEB. The estimates from the MWE HCP represent the best available data for this consultation, but we acknowledge the uncertainty of these estimates for the Eastern, Southern, and Western portions of the species' range.

The number of NLEBs that may be impacted by wind development in each state was calculated following these steps[3]: (1) determine the anticipated bat fatality rate for the geographic area of

[3] The MWE HCP is currently in development with the Service, a coalition of eight Midwestern states, and representatives of the wind energy industry. Much of the following information in this section comes from the draft

interest based on the results of post-construction monitoring studies; (2) determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB; and (3) multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB. For example, if the total estimated bat mortality from regional data is 12 bats/MW/year (or 1,200 bats/year for a 100 MW facility), and the number of NLEB fatalities among all bat fatalities was 1 out of 100 (or 1%), the total estimated mortality of the NLEB would be 12 fatalities/year.

1. *determine the anticipated bat fatality rate for the geographic area of interest based on the results of post-construction monitoring studies*

   The studies used to estimate all bat fatality rates for the MWE HCP were limited to those that were conducted in the eight Midwestern states within the range of the covered bat species in the MWE HCP (i.e., Indiana bat, NLEB, little brown bat). The following additional criteria were used to select post-construction monitoring studies: (1) the search interval had to be weekly or more frequent; (2) studies had to correct for carcass persistence and searcher efficiency using site-specific data; (3) the search interval had to be shorter than the mean carcass persistence rate; (4) only include the mortality rate for the most robust study method for studies that reported more than one mortality rate; and (5) only include the bat fatality estimates from control turbines for curtailment study projects. These studies were further modified to account for unsearched areas where bats were expected to fall by applying a correction factor (sensu Hull and Muir 2013) if the study included search areas smaller than 100 m search radii. Fatality rates must also be representative of the period over which future mortality is being estimated; therefore, rates were adjusted to account for bat mortality that occurred during from April 1 to October 31, which is inclusive of the time frame within which all NLEB mortalities have been documented.

   Based on these criteria, 17 fatality monitoring studies were selected to estimate fatality of all bats within the MWE HCP states. Of these 17 studies, two were conducted in Minnesota, three in Wisconsin, three in Iowa, four in Illinois, two in Indiana, and three in Ohio. Reported bat fatality rates (adjusted as described above) were variable across projects and ranged from a low of 1.42 bats/MW/study period at the Big Blue project in Minnesota (Fagen Engineering, LLC 2014), to 38.25 bats/MW/study period at the Cedar Ridge project in Wisconsin (BHE Environmental 2010). The mean bat fatality rate was 17.55 bats/MW/year. This estimate is similar to pre-WNS values surveys in Maryland (15.61 bats/MW; Young et al. 2011) and Pennsylvania (14.4 bats/MW; Taucher et al.

MWE HCP being written by Leidos, Inc. The analytical process used here was developed and approved by the Service; therefore, the data derived from this study currently represents the best available information to inform this analysis.

2012), which addresses some of the uncertainty of using Midwest estimates for the entire range.

2. *determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB*

   The MWE HCP used 71 studies to estimate species composition for NLEBs. This was a larger pool than the more restrictive studies used to determine the all bat fatality rate because the purpose was to capture all available data on NLEB mortality in the Midwest. Of these 71 studies, three species of long-distance migrants made up the highest percentage of fatalities, totaling 88% of the 8,934 bat carcasses documented across all studies. Eastern red bats had the highest number of fatalities (3,893 bat carcasses or 44%), followed by hoary bats (2,328 bat carcasses or 26%), and silver-haired bats (1,621 bat carcasses or 18%). The next most common species found among fatalities were big brown bats (519 bat carcasses or 6%), followed by little brown bats (339 bat carcasses or 4%). NLEBs made up 0.09% (8 bat carcasses out of 8,934) of the fatality pool.

3. *multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB*

   Based on the estimated percentage of NLEBs (0.09%) among the mean bat fatality rate (17.55/MW/year), the mean estimated NLEB fatalities/MW/year was 0.0158. This NLEB fatality rate was then applied to the current installed wind capacity and projected build-out through 2022 to determine an estimated number of NLEB fatalities that would occur during each year over the term of this consultation assuming no avoidance and minimization measures would be in place. Based on these assumptions, we estimated that 5,654 NLEB fatalities could result from the projected wind capacity of 55,006 MW through 2022 (3,575 NLEBs from current facilities and 2,078 NLEBs from projected build-out; Table 4.13). There was an estimated 447 mortalities in 2014, and annual estimates increase every year by 42 individuals from 2015-2020 and 86 individuals in 2021 and 2022 for a total of 869 individuals in 2022. These are over-estimates because they do not account for avoidance and minimization measures that are currently applied at wind facilities, especially within the range of the endangered Indiana bat and it does not account for declines from WNS, especially in the Eastern range.

   Operational adjustments can be made to minimize mortality of bat species at wind facilities through two primary methods: (1) turbines are “feathered,” or rendered near motionless below the normal manufacturer’s cut-in speed, and (2) the cut-in speed is raised to a wind speed higher than the normal manufacturer’s cut-in speed during periods and in areas of greatest risk for bats. These adjustments have been found to significantly

reduce bat mortality because bat activity and mortality have been shown to have an inverse relationship with wind speed (Arnett et al. 2013). Some facilities within the range of the NLEB have already instituted these operational adjustments to avoid take of Indiana bats or as required by Indiana bat Habitat Conservation Plans. In addition, the wind industry has recently announced new best management practices establishing voluntary operating protocols, which they expect “to reduce impacts to bats from operating wind turbines by as much as 30 percent” (AWEA 2015b). According to AWEA, the agreement “involves wind operators’ voluntarily limiting the operations of turbines in low-wind speed conditions during the fall bat migration season, when research has shown bats are most at risk of collision” (AWEA 2015b). Given the large numbers of other bat species impacted by wind energy (Hein et al 2013) and the economic importance of bats in controlling agricultural or forest pest species (Boyles et al 2011), we anticipate that these new standards will be adopted by most wind energy facilities and ultimately required by wind-energy-siting regulators at state and local levels. It is possible that total fatalities will be reduced by as much as 50% if we include the effects of additional curtailment that is ongoing at many projects and the effects of WNS on the overall population.

4.7 OTHER ACTIVITIES THAT MAY AFFECT THE NLEB

The NLEB is likely to be affected by a variety of other activities which are excepted from incidental take prohibitions in the final 4(d) rule that are not covered by the general categories for removal from human structures, forest management, forest conversion, and wind turbine operation. These activities include, but may not be limited to:

- Disturbance/noise from with human activities not associated with timber harvest or forest conversion
- Lighting
- Use of pesticides for pest and vegetation control
- Spills/chemical contamination
- Water quality alteration
- Collision
- Noise from munitions, detonations, and training vehicles/aircraft
- Use of military training smoke and obscurants
- Bridge maintenance, repair, or replacement
- Subsurface drilling or blasting for utility line and road installation
- Use of waste pits to store contaminated fluids

4.7.1 EFFECTS OF OTHER ACTIVITIES

Disturbance/Noise

Noise and vibration and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities of the NLEB. Many activities may result in increased noise/vibration/disturbance that may result in effects to bats. Significant changes in noise levels in an area may result in temporary to permanent alteration of bat behaviors. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats. At low noise levels (or farther distances), bats initially may be startled, but they would likely habituate to the low background noise levels. At closer range and louder noise levels (particularly if accompanied by physical vibrations from heavy machinery and the crashing of falling trees) many bats would probably be startled to the point of fleeing from their day-time roosts and in a few cases may experience increased predation risk. For projects with noise levels greater than usually experienced by bats, and that continue for multiple days, the bats roosting within or close to these areas are likely to shift their focal roosting areas further away or may temporarily abandon these roosting areas completely.

There is limited literature available regarding impacts from noise (outside of road/traffic) on bats. Gardner et al. (1991) had evidence that an NLEB conspecific, Indiana bat, continued to roost and forage in an area with active timber harvest (see the timber harvest Section above regarding other similar studies for NLEB). They suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted that the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree.

Indiana bats have also been documented roosting within approximately 300 meters of a busy state route adjacent to Fort Drum Military Installation (Fort Drum) and immediately adjacent to housing areas and construction activities on Fort Drum (US Army 2014). Bats roosting or foraging in all of the examples above have likely become habituated to the noise/vibration/disturbance.

Table 4.1 shows the pathway we identified for NLEB responses to noise/disturbance, and it is possible that NLEBs will be disturbed by noise/disturbance. A small subset of disturbed individuals may be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from noise or disturbance, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Lighting

Bat behavior may be affected by lights when traveling between roosting and foraging areas. Foraging in lighted areas may increase risk of predation or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting.

Some bats seem to benefit from artificial lighting, taking advantage of high densities of insects attracted to light. For example, 18 species of bats in Panama frequently foraged around streetlights, including slow-flying edge foragers (Jung and Kalko 2010). However, seven species in the same study were not recorded foraging near streetlights. Bat activity differed among color of lights with higher activity at bluish-white and yellow-white lights than orange. Bat activity at streetlights varied for some species with season and moonlight (Jung and Kalko 2010). In summary, this study suggests highly variable responses among species to artificial lighting.

Some species appear to be adverse to lights. Downs et al. (2003) found that lighting of *Pipistrellus pygmaeus* roosts reduced the number of bats that emerged. In Canada and Sweden, *Myotis* spp. and *Plecotus auritus* were only recorded foraging away from street lights (Furlonger et al. 1987, Rydell 1992). Stone et al. (2009) found that commuting activity of lesser horseshoe bats (*Rhinolophus hipposideros*) in Britain and was reduced dramatically and the onset of commuting was delayed in the presence of high pressure sodium (HPS) lighting. Stone et al. (2012) also found that light-emitting diodes (LED) caused a reduction in *Rhinolophus hipposideros* and *Myotis* spp. activity. In contrast, there was no effect of lighting on *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, or *Nyctalus/Eptesicus* spp.

Although there is limited information regarding potential neutral, positive, or negative impacts to NLEB from increased light levels, slow-flying bats such as *Rhinolophus*, *Myotis*, and *Plecotus* species have echolocation and wing-morphology adapted for cluttered environments (Norberg and Rayner 1987), and emerge from roosts when light levels are low, probably to avoid predation by diurnal birds of prey (Jones and Rydell 1994). Therefore, we would generally expect that NLEB would avoid lit areas. In Indiana, Indiana bats avoided foraging in urban areas and Sparks et al. (2005) suggested that it may have been in part due to high light levels. Using captive bats, Alsheimer (2012) also found that the little brown bat (*M. lucifugus*), was more active in the dark than light.

Table 4.1 shows the pathway we identified for NLEB responses to lighting, and it is possible that NLEBs will experience reduced fitness from lighting. Although some adverse effects to NLEBs are reasonably certain to occur from lighting, we anticipate that relatively small numbers of bats

will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Pesticides

Herbicides and other pesticides may be used to control pests and weed species including noxious or invasive plants. Treatments typically occur in spring, early summer, or fall. Treatments can be applied either by hand, from a truck mounted boom sprayer withspray heads designed to minimize drift, or aerially. Herbicide and other pesticide applications typically occur during the day when bats are roosting, and often in the morning to avoid and minimize wind-induced drift.

Long-term sublethal effects of environmental contaminants, such as herbicides and other pesticides, on bats are largely unknown; however, environmentally relevant exposure levels of various contaminants have been shown to impair nervous system, endocrine, and reproductive functioning in other wildlife (Yates et al. 2014, Köhler and Triebskorn 2013, Colborn et al. 1993). Moreover, bats' high metabolic rates, longevity, insectivorous diet, migration-hibernation patterns of fat deposition and depletion, and immune impairment during hibernation, along with potentially exacerbating effects of WNS, likely increase their risk of exposure to and accumulation of environmental toxins (Secord et al. 2015, Yates et al. 2014, Geluso et al. 1976, Quarles 2013, O'Shea and Clark 2002).

Table 4.1 shows the pathway we identified for NLEB responses to the use of herbicides and other pesticides, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected or treated areas and thus may eat insects exposed to chemicals. Bats may also be directly exposed to herbicides or other pesticides sprayed in roosting areas. Although some adverse effects to NLEBs are reasonably certain to occur from herbicides and other pesticide use, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all herbicides and other pesticides must be used in accordance to their label instructions, which are designed to minimize water contamination and adverse effects to wildlife.

Spills/Chemical Contamination

Accidents during project operation could result in the leakage of hazardous chemicals into the environment which could affect water quality resulting in reduced densities of aquatic insects that bats consume. If an accident occurred and hazardous chemicals leaked into the environment, a rapid response from state and/or federal agencies would limit the size of the spill area. However, if chemicals did reach surface waters (streams and wetlands), a short-term reduction in both aquatic and terrestrial insects could occur, thus reducing the spring, summer, or autumn

prey base for foraging NLEB. If this occurred, it would be localized, thus allowing foraging NLEBs to move nearby and continue foraging.

Table 4.1 shows the pathway we identified for NLEB responses to spills and chemical contamination, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Although some adverse effects to NLEBs are reasonably certain to occur from spills and chemical contamination, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all projects are typically required to follow state and/or federal wetland permitting, stormwater management, and water quality standards.

Water Quality Alteration

Some projects may result in permanent loss from wetland and/or stream fill or temporarily reduce water quality from dust and sedimentation. Table 4.1 shows the pathway we identified for NLEB responses to water quality alteration. Activities that reduce quantity or quality of water sources and foraging habitat may impact bats, even if conducted while individuals are not present. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems. Since potential impacts from sedimentation are expected to be localized, foraging bats should have alternative drinking water and foraging locations. The surrounding landscape will continue to provide an abundant prey base of both terrestrial and aquatic insects during project construction, operation, and maintenance. Therefore, any potential direct effects to bats from a reduction in water quality are anticipated to be insignificant.

Collision

Collision has been documented for Indiana bats and other myotids. The Indiana bat recovery plan indicates that bats do not seem particularly susceptible to vehicle collisions, but it may threaten local populations in certain situations (Service 2007). Russell et al. (2009) assessed the level of mortality from road kills on a bat colony in Pennsylvania and collected 27 road-killed little brown bats and 1 Indiana bat. This study also cited unpublished data from the Penssylvania Game Commission documenting NLEB collision mortality. Curtis et al. (2014) indicates that a dead NLEB was found along a road in Kansas and was thought to have collided with a vehicle. Collision has been documented for other *Myotis* in Europe (Lesinski et al. 2011). Collision risk of bats varies depending on time of year, location of road in relation to roosting/foraging areas), the characteristics of their flight, traffic volume, and whether young bats are dispersing (Lesinski 2007, Lesinski 2008, Russell et al. 2009, Bennett et al. 2011).

It can be difficult to determine whether roads pose greater risk for bats colliding with vehicles or greater likelihood of deterring bat activity in the area (thus decreasing risk of collision). Many studies suggest that roads may serve as a barrier to bats (Bennett and Zurcher 2013, Bennett et al. 2013, Berthinussen and Altringham 2011, Wray et al. 2006). In most cases, we expect there will be a decreased likelihood of bats crossing roads (and therefore, reduced risk of collision) of increasing size (lanes).

Table 4.1 shows the pathway we identified for NLEB responses to collision, and we anticipated that NLEBs will be killed from collision with vehicles. Although some mortality is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state because of the decreased likelihood of bats crossing major roads. Also, we anticipate the likelihood of mortality will be reduced by the widely dispersed of new road construction and occupancy rates that are typically less than 50%.

Noise from Munitions, Detonations, and Training Vehicles, Aircraft

Recent studies have indicated that anthropogenic noise can alter foraging behavior and success of bats, including some gleaning species like the NLEB (Bunkley et al. 2015; Schaub et al. 2008; Siemers and Schaub 2011). Table 4.1 shows the pathway we identified for NLEB responses to noise from military training operations, and it is possible that NLEBs will be disturbed. A small subset of disturbed individuals may be harmed. However, studies indicate that indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance (Whitaker & Gummer 2002; Service 2010; USFWS 2009). Although some adverse effects to NLEBs may occur from noise from military operations, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Use of Military Training Smoke and Obscurants

Smoke/obscurants are used to conceal military movements and help protect troops and equipment in combat conditions. Although they would be primarily used during the day, smoke/obscurants may be deployed at night. Training on military installations may include, but is not limited to, smokes and obscurants such as fog oil, colored smoke grenades, white phosphorous, and graphite smoke. Research indicates that prolonged dermal and respiratory exposures to these items, except for the graphite smoke, could have adverse effects on roosting and foraging Indiana bats (Service 1998; Service 2012; Driver et al. 2002; USWFS 2009; NRC 1999). Given the similar roosting behavior and foraging locations of the NLEB, it is likely they will also be adversely affected by these smokes and obscurants.

Table 4.1 shows the pathway we identified for NLEB responses to the use of smokes and obscurants, and it is possible that NLEBs will be harmed depending on the specific circumstances. Although some adverse effects to NLEBs are reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the limited use of these chemicals and occupancy rates that are typically less than 50%. In addition, many military installations already limit the use of smokes and obscurants in areas that may affect the Indiana bat, further reducing the impact to NLEBs.

Bridge Maintenance, Repair, or Replacement

NLEBs have been found using bridges for day and night roosts in Illinois, Louisiana, Iowa, and Missouri (Feldhamer et al. 2003; Ferrara and Leberg 2009; Kiser et al. 2002; Benedict and Howell 2008; Droppelman 2014). Altering or removing bridges when occupied by NLEBs is expected to result in adverse effects. Bridge alteration refers to any bridge repair, retrofit, maintenance, and/or rehabilitation work activities that modifies the bridge to the point that it is no longer suitable for roosting.

Table 4.1 shows the two pathways we identified for NLEB responses to bridge work and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. We expect that NLEBs will be killed or injured bats during activities conducted while bats are present, and the removal of roosts can reduce fitness. Although some adverse effects to NLEBs are reasonably certain to occur from bridge maintenance, repair, or replacement, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Subsurface Drilling or Blasting

Surface-disturbing activities (such as drilling or blasting) in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003).

Table 4.1 shows the two pathways we identified for NLEB responses to drilling and blasting, and it is possible that NLEBs will be harmed. These activities can alter the flow of air and water through unknown hibernacula. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of timber harvest activities.

Use of Waste Pits to Store Contaminated Fluids

The oil and gas industry (and possibly other industries) occasionally use of temporary waste pits to store materials removed from drilling, including sand used during hydraulic fracturing treatments, wellbore cuttings, bentonite drilling muds, and fluids. These waste pits have been documented to attract and entrap wildlife. Bats may drink contaminated water or become trapped in waste pits and die. Table 4.1 shows the pathway we identified for NLEB responses to waste pits, and it is possible that NLEBs will be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from the use of waste pits, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

4.8 CONSERVATION MEASURES IN THE 4(D) RULE

In BOs, we consider how conservation measures included in the proposed action may reduce the severity of effects or the probability of exposure. Prohibitions adopted under the final 4(d) will reduce the severity of effects or the probability of exposure of NLEB to the full scope of activities that may affect the species through regulatory processes under section 7 and section 10 the Act. Under the final 4(d) rule, incidental take involving tree removal in the WNS zone is not prohibited if two conservation measures are followed. The first measure is the year-round application of a 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known NLEB hibernacula. The second conservation measure involves the temporary protection of known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree (which is equivalent to 1.6 acres) during the pup season (June 1-July 31). The 150 ft buffer covers 1.6 acres around a known maternity roost tree. In addition, incidental take is prohibited in hibernacula within the WNS zone; therefore, regardless of the buffer size, NLEBs are protected from take while in known hibernacula when they are most vulnerable.

To determine how these conservation measures reduce the severity of effects or probability of exposure, we compared the acreages affected by the conservation measures to the total forested habitat within the range of the NLEB (Table 4.14). As described in section 2.2, there are currently 1,508 known hibernacula and 1,412 known maternity roost trees. The year-round protection of forested habitat around hibernacula results in a total of 189,556 acres (0.05% of the total forested habitat) in 31 of 37 states (84% of the range) where activities that may affect the NLEB are subject to regulatory processes under sections 7 and 10 of the Act. The temporary protection of known, occupied maternity roosts results in a total of 2,259 acres (<0.001% of the total forested habitat) in 17 of 37 states (46% of the range) where activities that may affect the NLEB are subject to the same regulatory processes.

These two conservation measures are beneficial in that they protect known hibernating populations from take and help protect known maternity colonies from direct harm by temporarily protecting known maternity roost trees during the pup season. However, because known maternity roost trees likely represent a small fraction of the total, the beneficial effect of this conservation measure, which reduces the severity of effects, does not significantly reduce the probability of exposure. Additionally, known roost trees may be cut either before June 1st or after July 31st in compliance with the 4(d) rule, or during that time period with either an incidental take permit under section 10, or an incidental take statement under section 7. The hibernacula conservation measure is more protective in scope (i.e., timing, location, and severity). The severity of the effects and probability of exposure are somewhat reduced, but this beneficial effect extends only to known hibernacula. Like known maternity roost trees, known hibernacula likely represent a small fraction of the total.

4.9 SUMMARY OF IMPACTS OF INDIVIDUALS

Table 4.15 combines the total annual estimated effects of the activities quantified for timber harvest, prescribed fire, forest conversion, and wind turbine operation. Because fatalities from wind turbine operation increase every year between 2015 and 2022, we report the average annual wind fatalities over the time-frame of this consultation. Based on these estimations, we anticipate that up to 117,267 NLEB will be disturbed and 3,285 pups and 980 adults will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation.

The disturbance associated with timber harvest, prescribed burning, and forest conversion within maternity roosting areas during the active season (April – October) can cause volant bats to flee their roosts and expend additional energy while exposed to day-time predators. Our methodology computes the number of NLEB affected annually as 117,267 bats (or 1.2% of the population) (Table 4.16). We recognize that not all of the NLEB roosting in an activity area will necessarily respond to disturbance by fleeing their roosts, likely depending on the disturbance intensity and proximity; therefore, we consider this to be an overestimate. Table 4.16 shows that 66 percent of the potential disturbance in maternity roosting areas is due to timber harvest, 18 percent to forest conversion, and 17% to prescribed burning. Disturbance that disrupts normal behavior patterns and creates the likelihood of injury to listed species (e.g., causing a nocturnal species to travel during daylight hours) may result in harm.

Timber harvest, prescribed burning, and forest conversion may also occur in maternity roosting areas during the non-volant season (June 1 – July 31). Heat and smoke from prescribed burning, and tree removal from the other activities, may kill or injure a non-volant pup, who cannot flee the threat unless carried by its mother, which we do not presume precludes this potential harm. We estimate that up to 3,285 NLEB pups (0.1 percent of the total pup population) are exposed to potentially lethal habitat modification annually (Table 4.17). Prescribed burning may affect 56.6

percent of the total pup population (Table 4.17). The potential for death or injury resulting from prescribed burning depends largely on site-specific circumstances, e.g., fire intensity near the maternity roost tree and the height above ground of pups in the maternity roost tree. Not all fires through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We therefore consider this to be an overestimate. Timber harvest and forest conversion account for 33.8 and 9.6 percent of the estimated harm to non-volant pups, respectively (Table 4.17). Unlike prescribed burning, we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We assumed that 15 percent of pups would be injured or killed when their roost tree was felled.

Wind turbine operation and tree removal from timber harvest and forest conversion may also kill or injure adults when they are struck by turbines or when occupied roost trees are felled. We estimate that up to 980 NLEB adults (less than 0.02 percent of the total adult population) are exposed to potentially lethal wind turbines and habitat modification annually (Table 4.18). Wind turbine operation accounts for 66.3% of the adult mortality, followed by timber harvest (25.2%) and forest conversion (8.5%) (Table 4.18). As discussed in Section 4.1.5.2, we believe the wind fatalities may be overestimated by as much as 50% after accounting for population reductions from WNS and current and future curtailment. The adult mortality from tree removal is not as likely to be overestimated because we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy are affected.

Additional harm is anticipated for unquantified effects from removal from human structures and “other” activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers reported in Table 4.15 for reasons discussed above (see section 4.1). In addition, we consider some of the numbers for harm and disturbance in this section to be overestimates as discussed, and we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population. As populations decline as a result of WNS, the chances of any particular activity affecting northern long-eared bats becomes more remote.

4.10 IMPACTS TO POPULATIONS

As described above, individual NLEBs may experience decreased reproductive success and survival as a result of implementation of the final 4(d) rule. Of importance here though, is how these potential adverse effects to individual bats affect the overall health and viability of populations present within the action area. This is best done by looking at the maternity colony and hibernacula populations; however, we do not have enough information about local populations or when and where projects will occur relative to the species’ occurrence.

The finest-scale of analysis we have to examine effects on local populations is at the state level. States vary greatly in the number of maternity colonies estimated per state (Table 2.5). States in the Eastern range generally have the lowest estimated number of maternity colonies, ranging from 16 maternity colonies in Delaware to 6,984 colonies in West Virginia. States with small numbers of maternity colonies are likely at greater risk of extirpation from impacts to individuals. For example, Delaware has 16 maternity colonies estimated to be comprised of 20 females each, for a total adult population size of 640 individuals. Activities implemented according to the final 4(d) rule could disturb 9 individuals in Delaware per year, along with harm to 3 pups and 2 adults per year. If all the annual impacts occurred within one maternity colony, it is possible that the colony would be reduced by at least 10% in one year (2 adults killed from a colony with 20 females = 10%), and potentially more if the 3 pups were also killed. Losses to very small populations may not be sustainable at the local-level. It is possible that the loss of 10% of the maternity colony could result in the loss of that colony, but it is unlikely that that level of impact would occur within a single maternity colony every year. However, areas hardest hit by WNS are likely at greatest risk (i.e., currently much of the Eastern range).

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states (Table 4.16), less than 1% of pups will be harmed in all states (Table 4.17), and less than 1% of adults will be harmed in all states (Table 4.18). Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities.

Where the species has substantially declined as a result of WNS, the surviving members of the population may be resilient or resistant to WNS. These surviving populations are particularly important to the persistence of the populations. The individual effects analysis indicates that some additional impacts will occur as a result this action. We do not know at this time if the impacts from this action are additive; however, even if the potential mortality from these activities is additive to the impacts from WNS, it is likely that the species will persist in these states based on the number of maternity colonies and widely-dispersed nature of the activities.

Based on the relatively small numbers affected annually compared to the state population sizes, we do not anticipate population-level effects to the NLEB. We conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species. Because we do not anticipate population-level impacts from our action, our analysis of effects to the NLEB is complete.

4.11 INTERRELATED AND INTERDEPENDENT ACTIONS

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. At this time, we are unaware of actions that are interrelated and interdependent with the final 4(d) rule that have not already been considered in this BO.

4.12 TABLES AND FIGURES FOR EFFECTS OF THE ACTION

Table 4.1. Exposure-response analysis for activities conducted in accordance with the final 4(d) rule that may affect the NLEB.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Removal from Human Structures	Exclusion	Using exclusion to make a known roost unsuitable	Year-round; indirect effect	All occupied areas except hibernacula	Adults	Reduced fitness	Loss of structures where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Removal from Human Structures	Rodenticides and sticky traps	Using rodenticides and sticky traps to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Activities conducted while bats are present are likely to kill or injure individuals. We expect this threat to be reduced through the implementation of BMPs for bat removal.
Removal from Human Structures	Eviction Devices	Using eviction or exclusionary devices to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Pups	Injury, mortality; harm	Use of exclusionary devices during the non-volant period is likely to result in the death of pups because females cannot return to take care of their young. However, many states require that exclusions be conducted outside of the non-volant period to minimize impacts.
Removal from Human Structures	Rabies testing	Euthanizing bats for rabies testing during removal	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Rabies testing will kill adults and volant juveniles. Data from MO and NY indicate that an average of 7 bats were killed bats per year during the most recent three years.
Forest Management	Timber Harvest	Reducing mid-story clutter adjacent to roost trees	Year-round; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts; travel corridors to foraging areas; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing unoccupied roost trees	Winter; indirect effect	Maternity roosting areas	Trees	Reduced fitness	Removal of roost trees where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing trees that provide habitat used for foraging, swarming, or staging	Year-round; indirect effect	All occupied areas except hibernacula	Insect prey, forest cover that supports (shelters) bat activity	Reduced fitness; energy expenditure for relocating from traditional use areas to alternative habitat	Loss of forest habitat decreases opportunities for growth and successful reproduction. Depending on location and size of the harvest, forest cover removal in the summer home range may cause a shift in home range or relocation. Loss of habitat in staging/swarming areas near hibernacula may cause a similar shift in habitat use for larger numbers of individuals, due to their seasonal concentration in these areas, and may reduce fall mating success and/or reduced fitness in preparation for spring migration
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities, Most other subactivities	Disturbance (noise, machinery exhaust, activity) associated with human activities	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Disturbance (fleeing); harass	Fleeing disturbance during daylight hours increases the likelihood of predation
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities	Altering the flow of air and water through hibernacula.	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of tree removal to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing occupied roost trees	Active seasos; direct effect	Maternity roosting areas	Individuals	Injury, mortality; harm	Removing occupied trees is likely to kill or injure pups and adults. For the purposes of this consultation, we assume that 15% of non-volant bats and 3% of adults may be injured or killed.
Forest Conversion	Construction Activities	Removal of forested habitat	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption.
Forest Management	Prescribed Burning	Creating snags, creating roost features in live trees	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of suitable roosts increasing opportunities for successful reproduction, more efficient use of forest habitat however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Forest Management	Prescribed Burning	Stimulating growth of ground cover and insect populations	Growing-season following the burn; indirect effect	Foraging areas	Insect prey	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of insect prey increasing foraging efficiency; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success
Forest Management	Prescribed Burning	Thinning mid-story clutter adjacent to roost trees	Growing-season following the burn; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management	Prescribed Burning	Destroying existing snags and other trees suitable for roosting	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Loss of suitable roosts decreases opportunities for successful reproduction, more efficient use of forest habitat
Forest Management	Prescribed Burning	Heat and smoke	Active season, day time; direct effect	Roosting areas (maternity and non-maternity)	Individuals; adults and volant juveniles	Disturbance (fleeing); harass	Fleeing the line of fire of a prescribed burn during daylight hours increases the likelihood of predation
Forest Management	Prescribed Burning	Heat and smoke	Active season, night time; direct effect	Foraging areas	Individuals; adults and volant juveniles	Disturbance (fleeing)	Fleeing the line of fire of a prescribed burn during night-time foraging is unlikely to cause injury
Forest Management	Prescribed Burning	Heat and smoke	Winter; direct effect	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm	Response depends on proximity of fire to hibernacula entrances and airflow patterns. Sufficient smoke entering hibernacula may cause injury or mortality.
Forest Management	Prescribed Burning	Heat and smoke	Non-volant season; direct effect	Maternity roosting areas	Individuals; non-volant juveniles	Injury, mortality; harm	Response varies with fire intensity and roost height; a combination of high-intensity burns and/or low roosts is likely to cause injury or mortality
Wind Energy	Operation	Sound from Operating Turbines	Active season, day and night; direct effect	Active season; direct effect	Individuals	Disturbance (fleeing)	Studies (Szewczak and Arnett 2006, Horn et al. 2008) have found evidence to suggest that bats are not likely to be negatively affected by sound from operating turbines.
Wind Energy	Operation	Collision with Operating Turbines	Active season, direct effect	All occupied areas except hibernacula	Individuals	Mortality; harm	Collision with wind wind turbines is likely to kill bats
Other	Most subactivities	Lighting	Active season, night; direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing), increased risk of predation; increase energy expenditure; harass	Foraging in lighted areas may increase risk of predation (leading to death) or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting. Some studies also show a beneficial effect of concentrating prey.
Other	Most subactivities	Use of pesticides and herbicides for pest and vegetation control	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Bats may also be directly exposed to herbicides sprayed in roosting areas. Effects are reduced because all herbidices and pesticides must be used in accordance with their label.
Other	Most subactivities	Chemical contamination from use or spills in/around bat habitat	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals.
Other	Most subactivities	Water Quality Alteration; sedimentation	Active season, indirect effect	All occupied areas except hibernacula	Insect prey	Reduced fitness	Temporary effects on water quality could occur during construction, which could reduce local insect populations. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems.

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Other	Military Operations	Noise from munitions, detonations, and training vehicles, including aircraft	Active season, direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing)	Fleeing disturbance increases the likelihood of predation. However, studies indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance.
Other	Military Operations	Use of Military Training Smoke and Obscurants	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Research indicates that prolonged dermal and respiratory exposures smokes and obsurants could have adverse effects on roosting and foraging bats.
Other	Bridge maintenance, repair, or replacement	Bridge work activities affect roosting bats	Active season, direct effect	Roosting areas (maternity and non-maternity)	Individuals	injury, mortality; harm	Bats may be injured or killed if they do not exit the bridge before it is either removed or the action results in effects to portion of the bridge where the bats are roosting.
Other	Bridge maintenance, repair, or replacement	Bridge work makes it unsuitable for roosting.	Inactive season, indirect effect	Roosting areas (maternity and non-maternity)	Individuals	Increased energy exposure; reduced fitness	Removal of bridges where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Other	Drilling	Subsurface drilling utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Blasting	Use of explosives to remove rocks for utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Storage Pits for oil and gas waste	Bats can become trapped in waste pits or drink contaminated water	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Bats may drink contaminated water or become trapped in waste pits and die.

Table 4.2. Mean annual harvest (acres) for each state included in the analysis (Source: U.S. Forest Service's Forest Inventory EVALIDator web-application Version 1.6.0.03; Available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp).

					Harvest (acres)						Percent of Annual Average Acres Harvested
Region	State	Acres of Forested Land	Years	N (years)	National Forest	Other Federal	State & Local	Private	Total	Average (acre/year)	
Midwest	Iowa	3,013,759	2009-2014	6	0	0	6,290	118,105	124,395	20,733	0.7%
Midwest	Illinois	4,847,480	2009-2014	6	0	7,392	0	220,038	227,430	37,905	0.8%
Midwest	Indiana	4,830,395	2009-2014	6	2,924	3,500	12,114	292,650	311,189	51,865	1.1%
Midwest	Michigan	20,127,048	2009-2014	6	79,571	0	340,950	1,189,042	1,609,563	268,261	1.3%
Midwest	Minnesota	17,370,394	2010-2014	5	43,708	2,977	391,433	360,229	798,346	159,669	0.9%
Midwest	Missouri	15,471,982	2009-2014	6	66,135	0	45,879	933,470	1,045,484	174,247	1.1%
Midwest	Ohio	8,088,277	2009-2014	6	1,945	0	15,572	467,607	485,124	80,854	1.0%
Midwest	Wisconsin	16,980,084	2009-2014	6	75,449	4,738	390,366	1,144,172	1,614,726	269,121	1.6%
Eastern	Connecticut	1,711,749	2009-2014	6	0	0	14,622	44,924	59,546	9,924	0.6%
Eastern	Delaware	339,520	2009-2014	6	0	0	2,540	13,625	16,164	2,694	0.8%
Eastern	Maine	17,660,246	2010-2014	5	0	0	86,952	2,285,161	2,372,113	474,423	2.7%
Eastern	Maryland	2,460,652	2009-2014	6	0	0	11,192	76,740	87,931	14,655	0.6%
Eastern	Massachusetts	3,024,092	2009-2014	6	0	0	16,196	66,640	82,837	13,806	0.5%
Eastern	New Hampshire	4,832,408	2009-2014	6	14,502	7,118	35,153	355,549	412,332	68,722	1.4%
Eastern	New Jersey	1,963,561	2009-2014	6	0	0	0	21,442	21,442	3,574	0.2%
Eastern	New York	18,966,416	2009-2014	6	0	0	62,807	1,002,449	1,065,256	177,543	0.9%
Eastern	Pennsylvania	16,781,960	2009-2014	6	10,966	8,625	128,668	1,026,196	1,174,456	195,743	1.2%
Eastern	Rhode Island	359,519	2009-2014	6	0	0	0	0	0	0	0.0%
Eastern	Vermont	4,591,280	2010-2014	5	4,858	0	5,596	245,487	259,941	51,988	1.1%
Eastern	Virginia	15,907,041	2008-2013	6	2,606	9,518	20,195	1,125,092	1,157,410	192,902	1.2%
Eastern	West Virginia	12,154,471	2009-2014	6	0	0	0	463,133	463,133	77,189	0.6%
Southern	Arkansas	18,754,916	2009-2014	6	193,868	11,975	43,919	2,411,963	2,661,725	443,621	2.4%
Southern	Kentucky	12,471,762	2006-2013	8	17,706	8,644	4,873	847,274	878,496	109,812	0.9%
Southern	Mississippi	19,541,284	2006-2014	9	68,994	21,053	60,562	3,273,286	3,423,895	380,433	1.9%
Southern	North Carolina	18,587,540	2003-2014	12	0	29,351	60,638	2,276,778	2,366,767	197,231	1.1%
Southern	Tennessee	13,941,333	2005-2013	9	0	12,837	3,028	1,151,325	1,167,190	129,688	0.9%
Western	Kansas	2,502,434	2009-2014	6	0	6,205	0	57,781	63,985	10,664	0.4%
Western	Nebraska	1,576,174	2009-2014	6	0	0	1,221	91,823	93,044	15,507	1.0%
Western	North Dakota	759,998	2009-2014	6	0	0	0	0	0	0	0.0%
Western	South Dakota	1,910,934	2009-2014	6	163,971	0	1,489	52,375	217,834	36,306	1.9%
	Total	281,528,709			747,203	133,933	1,762,255	21,614,356	24,261,754	3,669,077	1.3%

Table 4.3. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season harvest in maternity roosting areas.

Region	State	A. Harvest, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.808	619
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.701	1,469
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.701	1,207
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.701	5,240
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.808	6,706
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.701	2,831
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.701	2,111
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.701	7,493
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.359	30
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.359	5
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.701	2,767
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.359	24
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.359	30
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.359	215
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.359	37
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.359	1,880
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.359	2,104
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.359	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.359	163
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.359	2,963
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.359	1,316
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.701	17,961
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.701	2,772
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.808	9,309
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.701	4,892
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.359	1,695
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.808	172
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.808	250
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.808	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.808	585
	Total	2,150,079	281,528,709	0.764%		120,495		76,846

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.4. Estimated numbers of NLEB pups affected (harmed) annually by non-volant season harvest in maternity roosting areas.

Region	State	A. Havest, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	3,462	3,013,759	0.115%	6.3%	218	0.269	9
Midwest	Illinois	6,330	4,847,480	0.131%	9.4%	598	0.234	21
Midwest	Indiana	8,661	4,830,395	0.179%	5.7%	491	0.234	18
Midwest	Michigan	44,800	20,127,048	0.223%	4.8%	2,131	0.234	75
Midwest	Minnesota	26,665	17,370,394	0.154%	8.9%	2,364	0.269	96
Midwest	Missouri	29,099	15,471,982	0.188%	4.0%	1,151	0.234	41
Midwest	Ohio	13,503	8,088,277	0.167%	6.4%	859	0.234	31
Midwest	Wisconsin	44,943	16,980,084	0.265%	6.8%	3,048	0.234	107
Eastern	Connecticut	1,657	1,711,749	0.097%	1.4%	24	0.120	1
Eastern	Delaware	450	339,520	0.133%	0.8%	4	0.120	1
Eastern	Maine	79,229	17,660,246	0.449%	1.4%	1,125	0.234	40
Eastern	Maryland	2,447	2,460,652	0.099%	0.8%	19	0.120	1
Eastern	Massachusetts	2,306	3,024,092	0.076%	1.0%	24	0.120	1
Eastern	New Hampshire	11,477	4,832,408	0.237%	1.5%	170	0.120	4
Eastern	New Jersey	597	1,963,561	0.030%	4.8%	29	0.120	1
Eastern	New York	29,650	18,966,416	0.156%	5.0%	1,491	0.120	27
Eastern	Pennsylvania	32,689	16,781,960	0.195%	5.1%	1,669	0.120	30
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.120	0
Eastern	Vermont	8,682	4,591,280	0.189%	1.5%	129	0.120	3
Eastern	Virginia	32,215	15,907,041	0.203%	7.3%	2,350	0.120	43
Eastern	West Virginia	12,891	12,154,471	0.106%	8.1%	1,044	0.120	19
Southern	Arkansas	74,085	18,754,916	0.395%	9.9%	7,306	0.234	256
Southern	Kentucky	18,339	12,471,762	0.147%	6.1%	1,127	0.234	40
Southern	Mississippi	63,532	19,541,284	0.325%	5.2%	3,282	0.269	133
Southern	North Carolina	32,938	18,587,540	0.177%	6.0%	1,990	0.234	70
Southern	Tennessee	21,658	13,941,333	0.155%	6.2%	1,344	0.120	25
Western	Kansas	1,781	2,502,434	0.071%	3.4%	61	0.269	3
Western	Nebraska	2,590	1,576,174	0.164%	3.4%	88	0.269	4
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.269	0
Western	South Dakota	6,063	1,910,934	0.317%	3.4%	206	0.269	9
	Total	612,736	281,528,709	0.218%		34,339		1,109

[1] We prorated the total annual harvest for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.5. Estimated numbers of NLEB adults affected (harmed) annually by active season harvest in maternity roosting areas.

Region	State	A. Havest, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.081	2
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.071	5
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.071	4
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.071	16
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.081	21
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.071	9
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.071	7
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.071	23
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.036	1
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.036	1
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.071	9
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.036	1
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.036	1
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.036	1
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.036	1
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.036	6
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.036	7
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.036	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.036	1
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.036	9
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.036	4
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.071	55
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.071	9
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.081	29
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.071	15
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.036	6
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.081	1
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.081	1
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.081	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.081	2
	Total	2,150,079	281,528,709	0.764%		120,495		247

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.6. Prescribed fire (acres) within forested lands from 2002-2014 for each state included in the analysis (Source: National Interagency Fire Center, modified using the percent of prescribed fire within forested lands in each state from the 2012 National Prescribed Fire Use Survey Report).

Region	State	Acres of Forested Land	Average Annual Acres of Forest Land Burned	Minimum Annual Acres of Forest Land Burned	Maximum Annual Acres of Forest Land Burned	Percent of Average Available Habitat Burned
Midwest	Iowa	3,013,759	10,365	251	26,741	0.3%
Midwest	Illinois	4,847,480	8,102	626	21,890	0.2%
Midwest	Indiana	4,830,395	6,385	1,962	12,600	0.1%
Midwest	Michigan	20,127,048	9,325	1,669	16,652	0.0%
Midwest	Minnesota	17,370,394	102,512	48,837	158,160	0.6%
Midwest	Missouri	15,471,982	35,419	-	95,268	0.2%
Midwest	Ohio	8,088,277	2,781	259	6,767	0.0%
Midwest	Wisconsin	16,980,084	15,831	2,836	25,495	0.1%
Eastern	Connecticut	1,711,749	53	-	113	0.0%
Eastern	Delaware	339,520	50	-	161	0.0%
Eastern	Maine	17,660,246	3	2	5	0.0%
Eastern	Maryland	2,460,652	2,631	524	11,823	0.1%
Eastern	Massachusetts	3,024,092	272	2	815	0.0%
Eastern	New Hampshire	4,832,408	103	35	209	0.0%
Eastern	New Jersey	1,963,561	7,115	-	14,549	0.4%
Eastern	New York	18,966,416	189	39	918	0.0%
Eastern	Pennsylvania	16,781,960	1,795	-	7,013	0.0%
Eastern	Rhode Island	359,519	19	-	97	0.0%
Eastern	Vermont	4,591,280	323	46	902	0.0%
Eastern	Virginia	15,907,041	13,570	5,768	20,546	0.1%
Eastern	West Virginia	12,154,471	718	87	2,950	0.0%
Southern	Arkansas	18,754,916	153,639	100,108	200,998	0.8%
Southern	Kentucky	12,471,762	8,207	3,495	12,097	0.1%
Southern	Mississippi	19,541,284	126,297	1,818	253,860	0.6%
Southern	North Carolina	18,587,540	109,273	38,869	170,668	0.6%
Southern	Tennessee	13,941,333	14,959	1,856	23,085	0.1%
Western	Kansas	2,502,434	77	7	134	0.0%
Western	Nebraska	1,576,174	7,432	2,883	17,339	0.5%
Western	North Dakota	759,998	6,291	1,413	8,464	0.8%
Western	South Dakota	1,910,934	5,171	383	9,291	0.3%
		281,528,709	648,908	213,775	1,119,611	0.2%

Table 4.7. Estimated numbers of NLEB affected (disturbed) annually by heat and smoke from active-season prescribed burning in maternity roosting areas.

Region	State	A. Active Season Burning (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	6,074	3,013,759	0.2%	6.3%	383	0.808	310
Midwest	Illinois	4,748	4,847,480	0.1%	9.4%	448	0.701	314
Midwest	Indiana	3,742	4,830,395	0.1%	5.7%	212	0.701	149
Midwest	Michigan	5,464	20,127,048	0.0%	4.8%	260	0.701	183
Midwest	Minnesota	60,072	17,370,394	0.3%	8.9%	5,325	0.808	4,306
Midwest	Missouri	20,755	15,471,982	0.1%	4.0%	821	0.701	576
Midwest	Ohio	1,630	8,088,277	0.0%	6.4%	104	0.701	73
Midwest	Wisconsin	9,277	16,980,084	0.1%	6.8%	629	0.701	441
Eastern	Connecticut	31	1,711,749	0.0%	1.4%	0	0.359	1
Eastern	Delaware	29	339,520	0.0%	0.8%	0	0.359	1
Eastern	Maine	2	17,660,246	0.0%	1.4%	0	0.701	1
Eastern	Maryland	1,542	2,460,652	0.1%	0.8%	12	0.359	5
Eastern	Massachusetts	159	3,024,092	0.0%	1.0%	2	0.359	1
Eastern	New Hampshire	60	4,832,408	0.0%	1.5%	1	0.359	1
Eastern	New Jersey	4,170	1,963,561	0.2%	4.8%	202	0.359	73
Eastern	New York	111	18,966,416	0.0%	5.0%	6	0.359	2
Eastern	Pennsylvania	1,052	16,781,960	0.0%	5.1%	54	0.359	20
Eastern	Rhode Island	11	359,519	0.0%	1.4%	0	0.359	1
Eastern	Vermont	189	4,591,280	0.0%	1.5%	3	0.359	2
Eastern	Virginia	7,952	15,907,041	0.0%	7.3%	580	0.359	209
Eastern	West Virginia	421	12,154,471	0.0%	8.1%	34	0.359	13
Southern	Arkansas	90,032	18,754,916	0.5%	9.9%	8,879	0.701	6,221
Southern	Kentucky	4,809	12,471,762	0.0%	6.1%	296	0.701	208
Southern	Mississippi	74,010	19,541,284	0.4%	5.2%	3,823	0.808	3,091
Southern	North Carolina	64,034	18,587,540	0.3%	6.0%	3,868	0.701	2,711
Southern	Tennessee	8,766	13,941,333	0.1%	6.2%	544	0.359	196
Western	Kansas	45	2,502,434	0.0%	3.4%	2	0.808	2
Western	Nebraska	4,355	1,576,174	0.3%	3.4%	148	0.808	120
Western	North Dakota	3,687	759,998	0.5%	3.4%	126	0.808	102
Western	South Dakota	3,030	1,910,934	0.2%	3.4%	103	0.808	84
	Total	380,260	281,528,709	0.1%		26,863		19,417

[1] We prorated the total annual burning for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.8. Estimated numbers of NLEB pups affected (harmed) annually by heat and smoke from non-volant season prescribed burning in maternity roosting areas.

Region	State	A. Non-Volant Season[1] Burning (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	1,731	3,013,759	0.1%	6.3%	109	0.269	30
Midwest	Illinois	1,353	4,847,480	0.0%	9.4%	128	0.234	30
Midwest	Indiana	1,066	4,830,395	0.0%	5.7%	60	0.234	15
Midwest	Michigan	1,557	20,127,048	0.0%	4.8%	74	0.234	18
Midwest	Minnesota	17,119	17,370,394	0.1%	8.9%	1,518	0.269	409
Midwest	Missouri	5,915	15,471,982	0.0%	4.0%	234	0.234	55
Midwest	Ohio	464	8,088,277	0.0%	6.4%	30	0.234	7
Midwest	Wisconsin	2,644	16,980,084	0.0%	6.8%	179	0.234	42
Eastern	Connecticut	9	1,711,749	0.0%	1.4%	0	0.120	1
Eastern	Delaware	8	339,520	0.0%	0.8%	0	0.120	1
Eastern	Maine	1	17,660,246	0.0%	1.4%	0	0.234	1
Eastern	Maryland	439	2,460,652	0.0%	0.8%	3	0.120	1
Eastern	Massachusetts	45	3,024,092	0.0%	1.0%	0	0.120	1
Eastern	New Hampshire	17	4,832,408	0.0%	1.5%	0	0.120	1
Eastern	New Jersey	1,188	1,963,561	0.1%	4.8%	58	0.120	7
Eastern	New York	32	18,966,416	0.0%	5.0%	2	0.120	1
Eastern	Pennsylvania	300	16,781,960	0.0%	5.1%	15	0.120	2
Eastern	Rhode Island	3	359,519	0.0%	1.4%	0	0.120	1
Eastern	Vermont	54	4,591,280	0.0%	1.5%	1	0.120	1
Eastern	Virginia	2,266	15,907,041	0.0%	7.3%	165	0.120	20
Eastern	West Virginia	120	12,154,471	0.0%	8.1%	10	0.120	2
Southern	Arkansas	25,658	18,754,916	0.1%	9.9%	2,530	0.234	591
Southern	Kentucky	1,371	12,471,762	0.0%	6.1%	84	0.234	20
Southern	Mississippi	21,092	19,541,284	0.1%	5.2%	1,089	0.269	294
Southern	North Carolina	18,249	18,587,540	0.1%	6.0%	1,102	0.234	258
Southern	Tennessee	2,498	13,941,333	0.0%	6.2%	155	0.120	19
Western	Kansas	13	2,502,434	0.0%	3.4%	0	0.269	1
Western	Nebraska	1,241	1,576,174	0.1%	3.4%	42	0.269	12
Western	North Dakota	1,051	759,998	0.1%	3.4%	36	0.269	10
Western	South Dakota	864	1,910,934	0.0%	3.4%	29	0.269	8
	Total	108,368	281,528,709	0.038%		7,656		1,859

[1] We prorated the total annual burning for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.9. Mean annual acres of forest conversion harvest for each state included in the analysis.

REGION	STATE	Acres of Forested Land	Approximate Acres of Forest Lost per Year (NLCD change 2001 to 2011)	Percent of Habitat Lost Annually	Approximate Acres of Forest Lost by 2022	Percent of Habitat Lost by 2022
Midwest	Iowa	3,013,759	2,520	0.1%	17,641	0.6%
Midwest	Illinois	4,847,480	6,156	0.1%	43,092	0.9%
Midwest	Indiana	4,830,395	4,002	0.1%	28,011	0.6%
Midwest	Michigan	20,127,048	44,704	0.2%	312,930	1.6%
Midwest	Minnesota	17,370,394	52,135	0.3%	364,942	2.1%
Midwest	Missouri	15,471,982	16,968	0.1%	118,775	0.8%
Midwest	Ohio	8,088,277	13,522	0.2%	94,655	1.2%
Midwest	Wisconsin	16,980,084	30,191	0.2%	211,334	1.2%
Eastern	Connecticut	1,711,749	2,940	0.2%	20,577	1.2%
Eastern	Delaware	339,520	1,492	0.4%	10,444	3.1%
Eastern	Maine	17,660,246	52,154	0.3%	365,076	2.1%
Eastern	Maryland	2,460,652	6,286	0.3%	43,999	1.8%
Eastern	Massachusetts	3,024,092	7,075	0.2%	49,526	1.6%
Eastern	New Hampshire	4,832,408	12,002	0.2%	84,016	1.7%
Eastern	New Jersey	1,963,561	6,045	0.3%	42,318	2.2%
Eastern	New York	18,966,416	14,117	0.1%	98,822	0.5%
Eastern	Pennsylvania	16,781,960	22,638	0.1%	158,468	0.9%
Eastern	Rhode Island	359,519	715	0.2%	5,003	1.4%
Eastern	Vermont	4,591,280	3,858	0.1%	27,008	0.6%
Eastern	Virginia	15,907,041	95,261	0.6%	666,824	4.2%
Eastern	West Virginia	12,154,471	12,700	0.1%	88,899	0.7%
Southern	Arkansas	18,754,916	115,372	0.6%	807,604	4.3%
Southern	Kentucky	12,471,762	23,167	0.2%	162,169	1.3%
Southern	Mississippi	19,541,284	162,759	0.8%	1,139,312	5.8%
Southern	North Carolina	18,587,540	130,835	0.7%	915,845	4.9%
Southern	Tennessee	13,941,333	54,006	0.4%	378,039	2.7%
Western	Kansas	2,502,434	4,224	0.2%	29,567	1.2%
Western	Nebraska	1,576,174	4,036	0.3%	28,252	1.8%
Western	North Dakota	759,998	1,826	0.2%	12,785	1.7%
Western	South Dakota	1,910,934	10,532	0.6%	73,725	3.9%
	TOTALS	281,528,709	914,237	0.3%	6,399,657	2.3%

Table 4.10. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.808	76
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.701	239
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.701	94
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.701	874
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.808	2,190
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.701	276
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.701	354
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.701	841
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.359	9
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.359	3
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.701	305
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.359	11
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.359	16
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.359	38
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.359	62
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.359	150
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.359	244
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.359	3
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.359	13
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.359	1,463
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.359	217
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.701	4,672
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.701	585
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.808	3,983
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.701	3,245
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.359	706
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.808	69
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.808	66
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.808	30
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.808	170
	Total	535,743	281,528,709	0.190%		32,673		21,004

[1] We prorated the total annual conversion for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.11. Estimated numbers of NLEB pups affected (harmed) annually by non-volant-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	421	3,013,759	0.014%	6.3%	27	0.269	2
Midwest	Illinois	1,028	4,847,480	0.021%	9.4%	97	0.234	4
Midwest	Indiana	668	4,830,395	0.014%	5.7%	38	0.234	2
Midwest	Michigan	7,466	20,127,048	0.037%	4.8%	355	0.234	13
Midwest	Minnesota	8,706	17,370,394	0.050%	8.9%	772	0.269	32
Midwest	Missouri	2,834	15,471,982	0.018%	4.0%	112	0.234	4
Midwest	Ohio	2,258	8,088,277	0.028%	6.4%	144	0.234	6
Midwest	Wisconsin	5,042	16,980,084	0.030%	6.8%	342	0.234	12
Eastern	Connecticut	491	1,711,749	0.029%	1.4%	7	0.120	1
Eastern	Delaware	249	339,520	0.073%	0.8%	2	0.120	1
Eastern	Maine	8,710	17,660,246	0.049%	1.4%	124	0.234	5
Eastern	Maryland	1,050	2,460,652	0.043%	0.8%	8	0.120	1
Eastern	Massachusetts	1,182	3,024,092	0.039%	1.0%	12	0.120	1
Eastern	New Hampshire	2,004	4,832,408	0.041%	1.5%	30	0.120	1
Eastern	New Jersey	1,010	1,963,561	0.051%	4.8%	49	0.120	1
Eastern	New York	2,358	18,966,416	0.012%	5.0%	119	0.120	3
Eastern	Pennsylvania	3,781	16,781,960	0.023%	5.1%	193	0.120	4
Eastern	Rhode Island	119	359,519	0.033%	1.4%	2	0.120	1
Eastern	Vermont	644	4,591,280	0.014%	1.5%	10	0.120	1
Eastern	Virginia	15,909	15,907,041	0.100%	7.3%	1,160	0.120	21
Eastern	West Virginia	2,121	12,154,471	0.017%	8.1%	172	0.120	4
Southern	Arkansas	19,267	18,754,916	0.103%	9.9%	1,900	0.234	67
Southern	Kentucky	3,869	12,471,762	0.031%	6.1%	238	0.234	9
Southern	Mississippi	27,181	19,541,284	0.139%	5.2%	1,404	0.269	57
Southern	North Carolina	21,849	18,587,540	0.118%	6.0%	1,320	0.234	47
Southern	Tennessee	9,019	13,941,333	0.065%	6.2%	560	0.120	11
Western	Kansas	705	2,502,434	0.028%	3.4%	24	0.269	1
Western	Nebraska	674	1,576,174	0.043%	3.4%	23	0.269	1
Western	North Dakota	305	759,998	0.040%	3.4%	10	0.269	1
Western	South Dakota	1,759	1,910,934	0.092%	3.4%	60	0.269	3
	Total	152,678	281,528,709	0.054%		9,311		317

[1] We prorated the total annual conversion for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.12. Estimated numbers of NLEB adults affected (harmed) annually by active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.081	1
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.071	1
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.071	1
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.071	3
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.081	7
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.071	1
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.071	2
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.071	3
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.036	1
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.036	1
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.071	1
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.036	1
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.036	1
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.036	1
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.036	1
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.036	1
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.036	1
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.036	1
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.036	1
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.036	5
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.036	1
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.071	15
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.071	2
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.081	13
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.071	10
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.036	3
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.081	1
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.081	1
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.081	1
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.081	1
	Total	535,743	281,528,709	0.190%		32,673		83

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.13. Estimated NLEB fatalities from wind energy operation created using current and projected wind capacity through 2022.

REGION	STATE	Installed Wind Capacity in 2014 (MW)	Projected Wind Capacity in 2020 (MW)	Projected Wind Capacity in 2030 (MW)	Mean Annual Build-out 2014-2020 (MW)	Mean Annual Build-out 2021-2022 (MW)	Current Fatality through 2014	Annual Fatality 2015	Annual Fatality 2016	Annual Fatality 2017	Annual Fatality 2018	Annual Fatality 2019	Annual Fatality 2020	Annual Fatality 2021	Annual Fatality 2022	Total Fatality All Years
Midwest	Iowa	5688	6200	17300	85	1110	90	91	93	94	95	97	98	115	133	906
Midwest	Illinois	3568	3980	19490	69	1551	56	57	59	60	61	62	63	87	112	616
Midwest	Indiana	1745	2610	13500	144	1089	28	30	32	34	37	39	41	58	76	375
Midwest	Michigan[1]	1531	1531	1850	0	32	24	24	24	24	24	24	24	25	25	219
Midwest	Minnesota	3035	3470	3990	73	52	48	49	50	51	53	54	55	56	56	472
Midwest	Missouri	459	1280	4350	137	307	7	9	12	14	16	18	20	25	30	151
Midwest	Ohio	435	2990	5320	426	233	7	14	20	27	34	41	47	51	55	295
Midwest	Wisconsin	648	1320	1640	112	32	10	12	14	16	17	19	21	21	22	152
Eastern	Connecticut	0	130	130	22	0	0	0	1	1	1	2	2	2	2	11
Eastern	Delaware[2]	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern	Maine	440	950	950	85	0	7	8	10	11	12	14	15	15	15	107
Eastern	Maryland	160	820	820	110	0	3	4	6	8	9	11	13	13	13	80
Eastern	Massachusetts	107	270	270	27	0	2	2	3	3	3	4	4	4	4	29
Eastern	New Hampshire	171	470	470	50	0	3	3	4	5	6	7	7	7	7	50
Eastern	New Jersey[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	New York	1748	1750	3860	0	0	28	28	28	28	28	28	28	28	28	249
Eastern	Pennsylvania[2]	1340	5580	5400	707	0	21	32	43	55	66	77	88	88	88	559
Eastern	Rhode Island[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	Vermont[2]	119	440	430	54	0	2	3	4	4	5	6	7	7	7	45
Eastern	Virginia	0	100	830	17	73	0	0	1	1	1	1	2	3	4	12
Eastern	West Virginia	583	600	2030	3	143	9	9	9	9	9	9	9	12	14	91
Southern	Arkansas	0	0	2550	0	255	0	0	0	0	0	0	0	4	8	12
Southern	Kentucky	0	0	950	0	95	0	0	0	0	0	0	0	2	3	5
Southern	Mississippi	0	0	450	0	45	0	0	0	0	0	0	0	1	1	2
Southern	North Carolina	0	750	750	125	0	0	2	4	6	8	10	12	12	12	65
Southern	Tennessee	29	29	1310	0	128	0	0	0	0	0	0	0	2	5	10
Western	Kansas[2]	2967	3420	3270	76	0	47	48	49	50	52	53	54	54	54	461
Western	Nebraska	812	1260	1360	75	10	13	14	15	16	18	19	20	20	20	155
Western	North Dakota	1886	2870	4710	164	184	30	32	35	38	40	43	45	48	51	362
Western	South Dakota	803	1260	2400	76	114	13	14	15	16	17	19	20	22	24	159
Totals		**28294**	**44100**	**100380**	**2634**	**5453**	**447**	**489**	**530**	**572**	**613**	**655**	**697**	**783**	**869**	**5654**

[1]Projections were held constant for Michigan between 2014 and 2020 because 2020 projections were already exceeded.

[2]Projections are expected to decline slightly between 2020-2030; however, we did not reduce capacity because we assume constructed facilities will continue to operate.

Table 4.14. Influence of conservation measures for tree removal activities included in the final 4(d) rule for the NLEB.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees	Acres Covered by Hibernacula Conservation Measure[1]	Acres Covered by Maternity Roost Tree Conservation Measure[2]	Acres of Forested Land	Percent of Total Available Habitat Covered by Measures
Midwest	Iowa	2	14	251	22	3,013,759	0.01%
Midwest	Illinois	44	39	5,531	62	4,847,480	0.12%
Midwest	Indiana	69	193	8,673	309	4,830,395	0.19%
Midwest	Michigan	77	25	9,679	40	20,127,048	0.05%
Midwest	Minnesota	15	102	1,886	163	17,370,394	0.01%
Midwest	Missouri	269	58	33,813	93	15,471,982	0.22%
Midwest	Ohio	32	4	4,022	6	8,088,277	0.05%
Midwest	Wisconsin	67	84	8,422	134	16,980,084	0.05%
Eastern	Connecticut	8	0	1,006	0	1,711,749	0.06%
Eastern	Delaware	2	0	251	0	339,520	0.07%
Eastern	Maine	3	0	377	0	17,660,246	0.00%
Eastern	Maryland	8	0	1,006	0	2,460,652	0.04%
Eastern	Massachusetts	7	16	880	26	3,024,092	0.03%
Eastern	New Hampshire	11	0	1,383	0	4,832,408	0.03%
Eastern	New Jersey	9	47	1,131	75	1,963,561	0.06%
Eastern	New York	90	27	11,313	43	18,966,416	0.06%
Eastern	Pennsylvania	322	157	40,475	251	16,781,960	0.24%
Eastern	Rhode Island	0	0	0	0	359,519	0.00%
Eastern	Vermont	16	0	2,011	0	4,591,280	0.04%
Eastern	Virginia	11	12	1,383	19	15,907,041	0.01%
Eastern	West Virginia	104	231	13,073	370	12,154,471	0.11%
Southern	Alabama	11	0	1,383	0	22,876,792	0.01%
Southern	Arkansas	77	310	9,679	496	18,754,916	0.05%
Southern	Georgia	6	20	754	32	24,768,236	0.00%
Southern	Kentucky	122	254	15,335	406	12,471,762	0.13%
Southern	Louisiana	0	0	0	0	14,540,135	0.00%
Southern	Mississippi	0	0	0	0	19,541,284	0.00%
Southern	North Carolina	29	101	3,645	162	18,587,540	0.02%
Southern	Oklahoma	9	0	1,131	0	12,646,138	0.01%
Southern	South Carolina	3	0	377	0	13,120,509	0.00%
Southern	Tennessee	61	50	7,668	80	13,941,333	0.06%
Western	Kansas	1	0	126	0	2,502,434	0.01%
Western	Montana	0	0	0	0	25,573,200	0.00%
Western	Nebraska	2	0	251	0	759,998	0.03%
Western	North Dakota	0	0	0	0	1,576,174	0.00%
Western	South Dakota	21	0	2,640	0	1,910,934	0.14%
Western	Wyoming	0	0	0	0	11,448,541	0.00%
	Total	1,508	1,744	189,556	2,790	406,502,260	0.05%

[1]Hibernacula buffer circles have a radius of 0.25 mi, which is 125.7 acres

[2]Maternity roost trees have a temporary buffer circle with a 150 ft radius, which is 1.6 acres

Table 4.15. Summary of annual disturbance and harm estimates from timber harvest, prescribed fire, forest conversion, and wind[4].

Region	State	Harass Timber Harvest	Harass Prescribed Fire	Harass Forest Conversion	Harm (pups) Timber Harvest	Harm (pups) Prescribed Fire	Harm (pups) Forest Conversion	Harm (adults) Timber Harvest	Harm (adults) Forest Conversion	Harm (adults) Average Wind	Total Annual Harassment	Total Annual Harm (pups)	Total Annual Harm (adults)
Midwest	Iowa	619	310	76	9	30	2	2	1	102	1,005	41	105
Midwest	Illinois	1,469	314	239	21	30	4	5	1	70	2,022	55	76
Midwest	Indiana	1,207	149	94	18	15	2	4	1	43	1,450	35	48
Midwest	Michigan	5,240	183	874	75	18	13	16	3	24	6,297	106	43
Midwest	Minnesota	6,706	4,306	2,190	96	409	32	21	7	53	13,202	537	81
Midwest	Missouri	2,831	576	276	41	55	4	9	1	18	3,683	100	28
Midwest	Ohio	2,111	73	354	31	7	6	7	2	36	2,538	44	45
Midwest	Wisconsin	7,493	441	841	107	42	12	23	3	18	8,775	161	44
Eastern	Connecticut	30	1	9	1	1	1	1	1	1	40	3	3
Eastern	Delaware	5	1	3	1	1	1	1	1	0	9	3	2
Eastern	Maine	2,767	1	305	40	1	5	9	1	13	3,073	46	23
Eastern	Maryland	24	5	11	1	1	1	1	1	10	40	3	12
Eastern	Massachusetts	30	1	16	1	1	1	1	1	3	47	3	5
Eastern	New Hampshire	215	1	38	4	1	1	1	1	6	254	6	8
Eastern	New Jersey	37	73	62	1	7	1	1	1	0	172	9	2
Eastern	New York	1,880	2	150	27	1	3	6	1	28	2,032	31	35
Eastern	Pennsylvania	2,104	20	244	30	2	4	7	1	67	2,368	36	75
Eastern	Rhode Island	0	1	3	0	1	1	0	1	0	4	2	1
Eastern	Vermont	163	2	13	3	1	1	1	1	5	178	5	7
Eastern	Virginia	2,963	209	1,463	43	20	21	9	5	2	4,635	84	16
Eastern	West Virginia	1,316	13	217	19	2	4	4	1	10	1,546	25	15
Southern	Arkansas	17,961	6,221	4,672	256	591	67	55	15	2	28,854	914	72
Southern	Kentucky	2,772	208	585	40	20	9	9	2	1	3,565	69	12
Southern	Mississippi	9,309	3,091	3,983	133	294	57	29	13	0	16,383	484	42
Southern	North Carolina	4,892	2,711	3,245	70	258	47	15	10	8	10,848	375	33
Southern	Tennessee	1,695	196	706	25	19	11	6	3	1	2,597	55	10
Western	Kansas	172	2	69	3	1	1	1	1	52	243	5	54
Western	Nebraska	250	120	66	4	12	1	1	1	18	436	17	20
Western	North Dakota	0	102	30	0	10	1	0	1	42	132	11	43
Western	South Dakota	585	84	170	9	8	3	2	1	18	839	20	21
	Total	76,846	19,417	21,004	1,109	1,859	317	247	83	650	117,267	3,285	980

[4] Wind is the mean annual estimate from 2015 to 2022 reported in Table 4.13.

Table 4.16. Summary of the activities expected to disturb NLEB annually. The total number of bats per state includes adults and pups.

Region	State	Total # Bats Harassed per year	Percent Harass from Burning	Percent Harass from Harvest	Percent Harass from Conversion	Total # Bats per State	Percent Total Bats Affected
Midwest	Iowa	1,005	30.8%	61.6%	7.6%	153,495	0.7%
Midwest	Illinois	2,022	15.5%	72.7%	11.8%	320,580	0.6%
Midwest	Indiana	1,450	10.3%	83.2%	6.5%	191,763	0.8%
Midwest	Michigan	6,297	2.9%	83.2%	13.9%	670,878	0.9%
Midwest	Minnesota	13,202	32.6%	50.8%	16.6%	1,244,835	1.1%
Midwest	Missouri	3,683	15.6%	76.9%	7.5%	428,922	0.9%
Midwest	Ohio	2,538	2.9%	83.2%	13.9%	360,360	0.7%
Midwest	Wisconsin	8,775	5.0%	85.4%	9.6%	806,715	1.1%
Eastern	Connecticut	40	2.5%	75.0%	22.5%	8,760	0.5%
Eastern	Delaware	9	11.1%	55.6%	33.3%	960	0.9%
Eastern	Maine	3,073	0.0%	90.0%	9.9%	175,734	1.7%
Eastern	Maryland	40	12.5%	60.0%	27.5%	6,720	0.6%
Eastern	Massachusetts	47	2.1%	63.8%	34.0%	11,160	0.4%
Eastern	New Hampshire	254	0.4%	84.6%	15.0%	25,740	1.0%
Eastern	New Jersey	172	42.4%	21.5%	36.0%	34,140	0.5%
Eastern	New York	2,032	0.1%	92.5%	7.4%	342,720	0.6%
Eastern	Pennsylvania	2,368	0.8%	88.9%	10.3%	307,800	0.8%
Eastern	Rhode Island	4	25.0%	0.0%	75.0%	1,860	0.2%
Eastern	Vermont	178	1.1%	91.6%	7.3%	24,420	0.7%
Eastern	Virginia	4,635	4.5%	63.9%	31.6%	416,880	1.1%
Eastern	West Virginia	1,546	0.8%	85.1%	14.0%	353,520	0.4%
Southern	Arkansas	28,854	21.6%	62.2%	16.2%	1,295,775	2.2%
Southern	Kentucky	3,565	5.8%	77.8%	16.4%	537,147	0.7%
Southern	Mississippi	16,383	18.9%	56.8%	24.3%	815,940	2.0%
Southern	North Carolina	10,848	25.0%	45.1%	29.9%	786,708	1.4%
Southern	Tennessee	2,597	7.5%	65.3%	27.2%	310,920	0.8%
Western	Kansas	243	0.8%	70.8%	28.4%	68,850	0.4%
Western	Nebraska	436	27.5%	57.3%	15.1%	43,335	1.0%
Western	North Dakota	132	77.3%	0.0%	22.7%	20,925	0.6%
Western	South Dakota	839	10.0%	69.7%	20.3%	52,515	1.6%
	Total	117,267	16.6%	65.5%	17.9%	9,820,077	1.2%

Table 4.17. Summary of the activities expected to harm NLEB pups annually.

Region	State	Total # Pups Harmed per year	Percent Harm from Burning	Percent Harm from Harvest	Percent Harm from Conversion	Total # Pups per State	Percent Total Pups Affected
Midwest	Iowa	41	73.2%	22.0%	4.9%	51,165	0.1%
Midwest	Illinois	55	54.5%	38.2%	7.3%	106,860	0.1%
Midwest	Indiana	35	42.9%	51.4%	5.7%	63,921	0.1%
Midwest	Michigan	106	17.0%	70.8%	12.3%	223,626	0.0%
Midwest	Minnesota	537	76.2%	17.9%	6.0%	414,945	0.1%
Midwest	Missouri	100	55.0%	41.0%	4.0%	142,974	0.1%
Midwest	Ohio	44	15.9%	70.5%	13.6%	120,120	0.0%
Midwest	Wisconsin	161	26.1%	66.5%	7.5%	268,905	0.1%
Eastern	Connecticut	3	33.3%	33.3%	33.3%	2,920	0.1%
Eastern	Delaware	3	33.3%	33.3%	33.3%	320	0.9%
Eastern	Maine	46	2.2%	87.0%	10.9%	58,578	0.1%
Eastern	Maryland	3	33.3%	33.3%	33.3%	2,240	0.1%
Eastern	Massachusetts	3	33.3%	33.3%	33.3%	3,720	0.1%
Eastern	New Hampshire	6	16.7%	66.7%	16.7%	8,580	0.1%
Eastern	New Jersey	9	77.8%	11.1%	11.1%	11,380	0.1%
Eastern	New York	31	3.2%	87.1%	9.7%	114,240	0.0%
Eastern	Pennsylvania	36	5.6%	83.3%	11.1%	102,600	0.0%
Eastern	Rhode Island	2	50.0%	0.0%	50.0%	620	0.3%
Eastern	Vermont	5	20.0%	60.0%	20.0%	8,140	0.1%
Eastern	Virginia	84	23.8%	51.2%	25.0%	138,960	0.1%
Eastern	West Virginia	25	8.0%	76.0%	16.0%	117,840	0.0%
Southern	Arkansas	914	64.7%	28.0%	7.3%	431,925	0.2%
Southern	Kentucky	69	29.0%	58.0%	13.0%	179,049	0.0%
Southern	Mississippi	484	60.7%	27.5%	11.8%	271,980	0.2%
Southern	North Carolina	375	68.8%	18.7%	12.5%	262,236	0.1%
Southern	Tennessee	55	34.5%	45.5%	20.0%	103,640	0.1%
Western	Kansas	5	20.0%	60.0%	20.0%	22,950	0.0%
Western	Nebraska	17	70.6%	23.5%	5.9%	14,445	0.1%
Western	North Dakota	11	90.9%	0.0%	9.1%	6,975	0.2%
Western	South Dakota	20	40.0%	45.0%	15.0%	17,505	0.1%
	Total	3,285	56.6%	33.8%	9.6%	3,273,359	0.1%

Table 4.18. Summary of the activities expected to harm NLEB adults annually.

Region	State	Total # Adults Harmed per year	Percent Harm from Harvest	Percent Harm from Conversion	Percent Harm from Wind	Total # Adults per State	Percent Total Adults Affected
Midwest	Iowa	105	1.9%	1.0%	97.1%	102,330	0.10%
Midwest	Illinois	76	6.6%	1.3%	92.1%	213,720	0.04%
Midwest	Indiana	48	8.3%	2.1%	89.7%	127,842	0.04%
Midwest	Michigan	43	37.0%	6.9%	56.1%	447,252	0.01%
Midwest	Minnesota	81	25.9%	8.6%	65.4%	829,890	0.01%
Midwest	Missouri	28	32.1%	3.6%	64.3%	285,948	0.01%
Midwest	Ohio	45	15.5%	4.4%	80.1%	240,240	0.02%
Midwest	Wisconsin	44	52.6%	6.9%	40.6%	537,810	0.01%
Eastern	Connecticut	3	29.6%	29.6%	40.7%	5,840	0.06%
Eastern	Delaware	2	50.0%	50.0%	0.0%	640	0.31%
Eastern	Maine	23	40.0%	4.4%	55.6%	117,156	0.02%
Eastern	Maryland	12	8.6%	8.6%	82.8%	4,480	0.26%
Eastern	Massachusetts	5	18.6%	18.6%	62.8%	7,440	0.07%
Eastern	New Hampshire	8	12.9%	12.9%	74.2%	17,160	0.05%
Eastern	New Jersey	2	50.0%	50.0%	0.0%	22,760	0.01%
Eastern	New York	35	17.1%	2.9%	80.0%	228,480	0.02%
Eastern	Pennsylvania	75	9.3%	1.3%	89.4%	205,200	0.04%
Eastern	Rhode Island	1	0.0%	100.0%	0.0%	1,240	0.08%
Eastern	Vermont	7	13.6%	13.6%	72.9%	16,280	0.05%
Eastern	Virginia	16	57.6%	32.0%	10.4%	277,920	0.01%
Eastern	West Virginia	15	26.7%	6.7%	66.7%	235,680	0.01%
Southern	Arkansas	72	76.9%	21.0%	2.1%	863,850	0.01%
Southern	Kentucky	12	77.4%	17.2%	5.4%	358,098	0.00%
Southern	Mississippi	42	68.6%	30.8%	0.6%	543,960	0.01%
Southern	North Carolina	33	45.1%	30.1%	24.8%	524,472	0.01%
Southern	Tennessee	10	60.8%	30.4%	8.9%	207,280	0.00%
Western	Kansas	54	1.9%	1.9%	96.3%	45,900	0.12%
Western	Nebraska	20	5.1%	5.1%	89.9%	28,890	0.07%
Western	North Dakota	43	0.0%	2.4%	97.6%	13,950	0.30%
Western	South Dakota	21	9.4%	4.7%	86.0%	35,010	0.06%
	Total	980	25.2%	8.5%	66.3%	6,546,718	0.01%

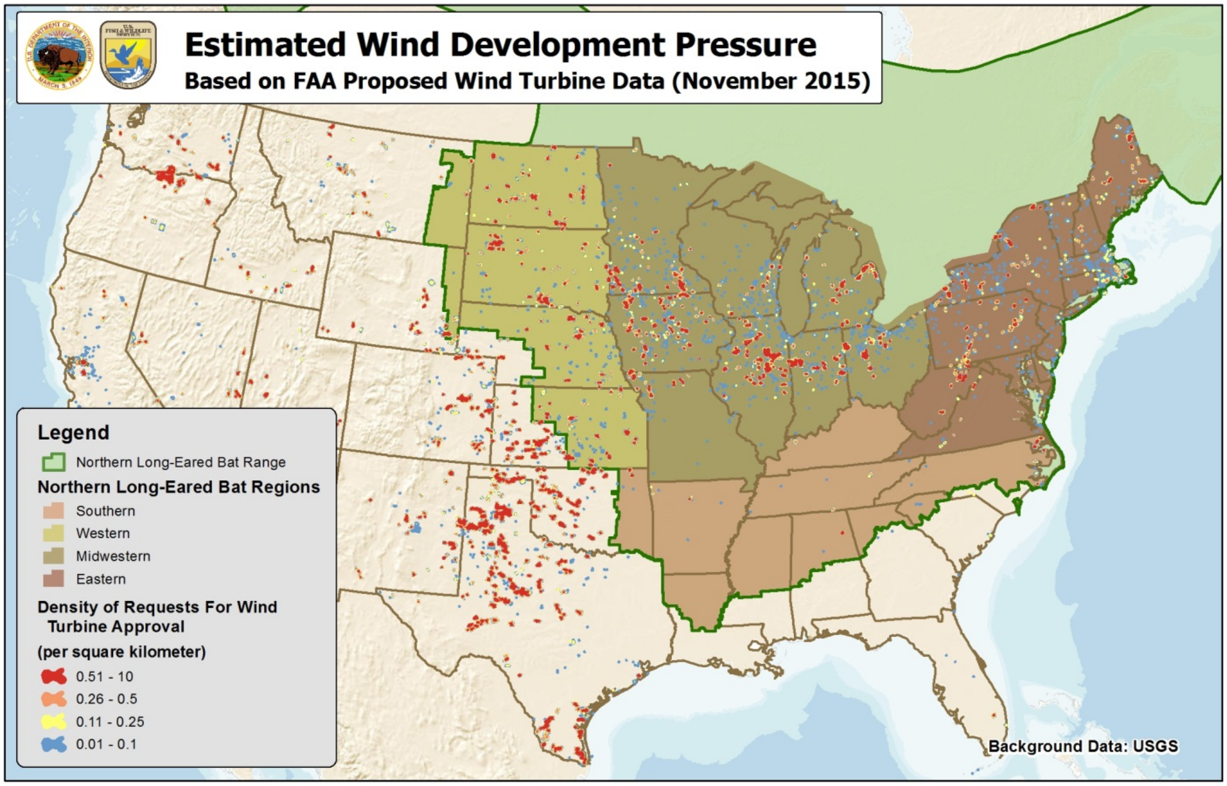

Figure 4.1. Estimated wind development pressure based on the Federal Aviation Administration's proposed wind turbine data.

5 CUMULATIVE EFFECTS

In the context of a consultation, cumulative effects are the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under section 7 of the ESA.

Section 4 of this BO discusses all actions that may affect the NLEB associated with the implementation of the final 4(d) rule. These include effects of state, tribal, local and private actions. These actions are typically included in this section; however, the action evaluated in this BO is the finalization and implementation of the final 4(d) rule, which includes state, tribal, local, and private actions. We acknowledge that some of the activities included in the effects of the action are cumulative effects, but we do not separate them in this BO.

6 CONCLUSION

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Although other factors, individually or in combination, are likely insignificant at the range-wide scale, they may exacerbate the effects of WNS at the local population scale, thereby accelerating declines and the likelihood of local extirpation due to the disease or reducing the population's ability to survive and potentially rebound. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

The species' foremost conservation need is to reduce or eliminate the threat of WNS. In areas impacted by WNS, the next priorities are to protect NLEB in hibernacula and maternity roost trees, and to continue to monitor populations in summer habitats (e.g., identify where the species continues to survive after the detection of Pd or WNS and determine the factors influencing its resilience).

From our assessment of the species' status/environmental baseline, we have observed NLEB population declines within a few years following the arrival of WNS, and can expect further declines as the disease moves through the Action Area. Based on post-WNS occupancy rates inferred from summer survey data and assumptions about colony size and distribution in forested habitats, we estimate that the population of NLEB is currently about 6,546,700 adult NLEB.

Activities that may affect the NLEB, but will not cause prohibited take under the final 4(d) rule, primarily include timber harvest, prescribed fire, forest conversion, and wind turbine operation. We estimate that these activities will disturb up to 117,267 volant NLEB (both adults and juveniles) each year, all within roosting areas (both maternity and non-maternity), and mostly (65.5 percent) resulting from timber harvest. The Action is expected to harm up to 3,285 non-volant juvenile NLEB annually, all within maternity roosting areas, and mostly resulting from prescribed burning and tree clearing activities conducted during the active season. The Action is also expected to harm up to 980 adults annually, mostly from wind turbine operation and removal of undocumented occupied roosts.

The disturbance estimate amounts to 1.2 percent of the total NLEB population, including young-of-the-year (1 per adult female following parturition), and less than 2.3% of the total number of NLEBs in each individual state. We do not expect disturbance of less than 2.3% of a state's population to significantly affect the numbers or reproduction of the species in the states, as only a small fraction of those fleeing roosts due to disturbance are likely to suffer injury from day-time predators or other hazards encountered before roosting elsewhere. Further, we do not expect disturbance to significantly affect the distribution of the species on the Forests, as the disturbances causing it are temporary, ceasing when project-level activity ceases.

The harm estimate of 3,285 NLEB pups amounts to less than 0.1 percent of the total population of non-volant pups. Less than 1% of the total number of NLEB pups may be harmed in individual states. However, these numbers are overestimates. As noted above, most of this harm is caused by prescribed burning and tree clearing activities, where the potential for death or injury depends largely on site-specific circumstances, e.g., the likelihood of felling a tree containing a maternity colony. Not all tree clearing activities through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. The same is true for prescribed fire. We also estimated that 980 adults (less than 0.02% of the total population) may be affected by wind turbine operation and tree clearing activities. Less than 1% of the total number of NLEB adults may be affected in all individual states. These numbers are more realistic estimations because we did not assume that all potentially vulnerable individuals would be affected – we assumed that only 3% of adults would be impacted.

There are no additional interrelated and interdependent actions to the proposed Action or cumulative effects that are not included in the analysis of the proposed Action.

The final 4(d) rule determined that the conservation of the NLEB as a threatened species is best served by limiting the full suite of prohibitions applicable to endangered species under section 9 of the Act to its most vulnerable life stages, i.e., while in hibernacula or in maternity roost trees

within the WNS zone, and to activities, tree removal in particular, that are most likely to affect the species. Activities excepted from the requirements to obtain incidental take statements or incidental take permits will affect relatively small numbers of individuals, which is not anticipated to impair conservation efforts or the recovery potential of the species. The vast majority of individuals and populations that survive WNS are unaffected by these activities. It is likely that the species will persist in the individual states based on the number of maternity colonies and widely-dispersed nature of the activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not cause population-level declines in this species.

The Service defines "to jeopardize the continued existence of a listed species" as to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species. After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service's biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB. The Service has not proposed or designated critical habitat for this species; therefore, none is affected.

Incidental take that is not expressly prohibited under the final 4(d) rule does not require exception in an Incidental Take Statement. This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in section 1.3 of this BO, which provides a process by which agencies may verify that their proposed actions do not include activities that would cause prohibited incidental take. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

7 REINITIATION NOTICE

Reinitiation of formal consultation is required and shall be requested by the Service, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (b) If the identified action is subsequently modified in a manner that has an effect to the listed species or critical habitat that was not considered in the biological opinion; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. The section 7 regulations also require that consultation be reinitiated if the amount or extent of taking specified in the incidental take

statement is exceeded (50 CFR 402.16); however, this condition does not apply to this consultation because all incidental take resulting from actions carried out in compliance with the final 4(d) rule is not prohibited.

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